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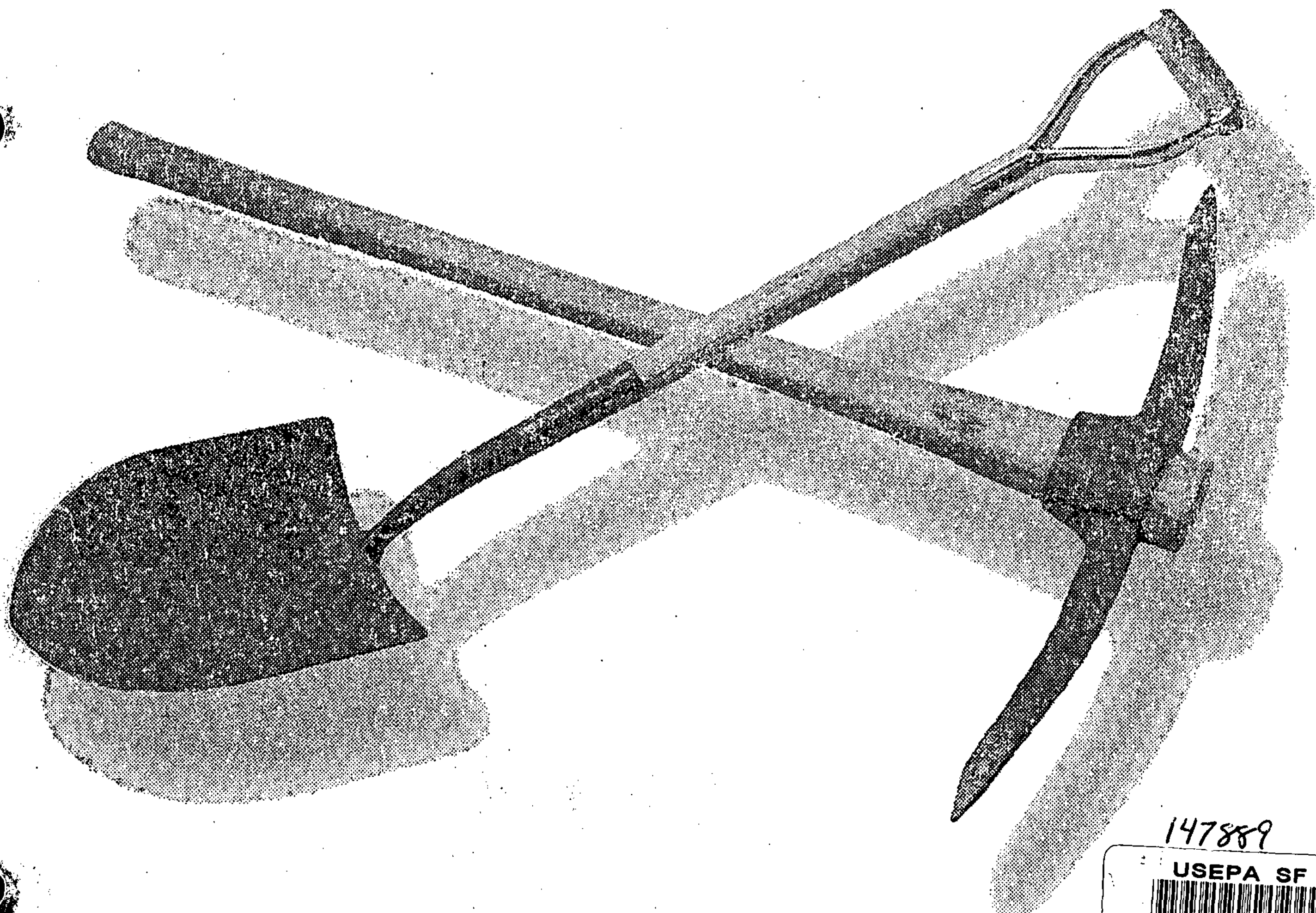
EPA

Supplement No. 1B Bunker Hill Mine Conceptual Model

Final Data Summary for 1998/1999 Monitoring Program



Supplement No. 1B—Bunker Hill Mine Conceptual Model—Final Data Summary for 1998/1999 Monitoring Program

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1.0 Introduction

This memorandum presents a summary of flow and analytical data from the 1998/1999 AMD monitoring program that was conducted at the Bunker Hill Mine between October 1998 and September 1999. The monitoring program is part of the conceptual model component of the presumptive remedy for the Bunker Hill Mine Water Management project (RAC WA 021-RI-CO-105G).

This data summary follows *Supplement No. 1A—Conceptual Model, Interim Data Summary for the 1998/1999 Monitoring Program, Bunker Hill Mine Water Management Project* technical memorandum (CH2M HILL, 1999a), which is included as Appendix B to the final *Acid Mine Drainage—Bunker Hill Mine Water Conceptual Model* technical memorandum (CH2M HILL, 1999b). This final data summary includes all data collected during the 1998/1999 monitoring program which began in October 1998 and was completed in September 1999.

1.1 Monitoring Program Purpose and Objectives

The purpose of the AMD monitoring program is to further the understanding of the mine water and to help refine the conceptual model and the presumptive remedy components that are being used to develop a long-term mine water management system. This is achieved through the assessment of current water quality and quantity conditions in mine water that is discharging from the Kellogg Tunnel, and in the tributary waters within the mine. Specific objectives of the monitoring program include the following:

- Support the identification and assessment of potential AMD generation mitigation measures, AMD collection, conveyance, and storage measures, and AMD treatment measures.
- Evaluate if current conditions have changed significantly since the last mine water evaluation conducted in the mid-1980s by John Riley and other University of Idaho researchers.

Additional objectives that pertain to this final data summary include the validation of average annual flows and water quality parameters that may be used in the design of a treatment plant.

1.2 Memorandum Organization

This memorandum is organized similarly to previous data summaries. A section for Conclusions has been added to address the additional objectives mentioned above. The memorandum consists of the following subsections:

- Section 1—Introduction
- Section 2—1998/1999 Mine Water Monitoring Program
- Section 3—Monitoring Results

- Section 4—Summary
- Section 5—Recommendations
- Section 6—References

2.0 1998/1999 Mine Water Monitoring Program

The 1998/1999 mine water monitoring program was implemented in phases. Phase I locations were selected to monitor major flow paths at historic sampling locations. The purpose of the phase I locations was to identify any discrepancies between current and historical flow paths, flow rates, and metals concentrations. Phase II locations were identified to investigate specific flow paths in more detail based on the results of the first few rounds of data from the Phase I locations.

The rational for monitoring each sampling location, and the flow measurement devices selected for each location are summarized in Table 2 of the final *Acid Mine Drainage—Bunker Hill Mine Water Conceptual Model* technical memorandum (CH2M HILL, 1999b).

The 1998/1999 monitoring program included fourteen monitoring locations on three different mine levels (Levels 3, 5, and 9) that were monitored regularly. In addition, five locations on different mine levels had been monitored once during spot-sampling events.

The fourteen locations monitored regularly include twelve Phase I locations that have been monitored since November 1998. A three-character code was developed to abbreviate each location during sample preparation and analysis. The first number refers to the mine level, and other two letters indicate the location. Phase I locations are Homestake Drift (3HD), Becker (5BK), Williams (5WM), West Reed (5WR), Cherry Raise (9CR), Bailey Ore Chute (9BO), Stanley Ore Chute (9SO), Stanly Crosscut (9SX), Loadout Area (9LA), No. 2 Raise Pumps (9PU), Barney Switch (9BS), and Kellogg Tunnel (9KT). The two Phase II locations that were added to the monitoring program in February and May 1999 are the Van Raise (9VR) and Stanley Ore Chute II (9S2). The Stanly Crosscut on 9 level (9SX) was added to the analytical portion of the program in February 1999; flow has been measured at 9SX since November 1998.

Missing flow and metal loads were identified when flow and mass balances were determined in *Interim Data Evaluation, Bunker Hill Mine Water 1998/1999 Sampling Program* (CH2M HILL, 1999c). As additional point sources were identified, they were incorporated into the 1998/1999 monitoring program. Five 'spot sample' locations on different mine levels have been included to refine the conceptual model. These locations consist of the Discovery Cut on 1 Level (1DC), Buckeye Adit on 2 Level (2BA), Utz on 3 Level (3UTZ), 7 Level Dam (7LD), and Veral Dam on 11 Level (11VD).

Additional monitoring locations were incorporated as part of the scope of parallel reconnaissance tasks for the Flood-Stanly Ore Body and the Hanna Stope. These locations include Ramsey Drive (9RD), Morgan Drive (9MG), Dull Raise (9DR), 9 Level Cherry Vent Raise (9CV), and Bailey Cross Cut (9BX) on 9 Level, and 10 level Pumps (10PU) that were part of the Flood-Stanly Reconnaissance task. Sullivan No. 2 Raise (2SU) on 2 Level, Hanna Stope Draw Point (9DP), Hanna Stope Drainage (6HS), and Pond before Draw Points (6DP) on 6 Level were monitored as part of the Hanna Stope Reconnaissance task. A summary of findings for these two tasks can be found in *West Fork Milo Creek Spring 1999 Observations* technical memorandum (CH2M HILL, 1999d), *Field Reconnaissance of Hanna Stope*

(CH2M HILL, 1999e) and *Hanna Stope Water Quality Sample Results* technical memoranda (CH2M HILL, 1999f).

All sample locations and analytical parameters, field duplicates, and field blanks collected for the 1998/1999 Monitoring Program are chronologically listed in Table 1.

Flow measurement, sample collection, field measurement, and sample analysis protocols have remained the same since the beginning of the monitoring program.

TABLE 1

Summary of Sample Locations and Analytical Parameters for the 1998/1999 Monitoring Program

Supplement No. 1B – Conceptual Model, Final Data Summary for the 1998/1999 Monitoring Program - Bunker Hill Mine Water Management

Sample Date	Monitoring Location																					
	1DC	2BA	3UTZ	3HD	5BK	5WM	5WR	7LD	9VR	9CR	9BO	9SO	9SX	9S2	9LA	9PU	9BS	9KT	11VD	F/S Recon	Hanna Stope
10/16/98															flow						
10/27/98													flow		flow						
11/6/98					X	X	X														
11/13/98										X	X	X	F		X	X	X	X[D]			
11/20/98				X[D]																	
12/1/98										X	X	X	flow		X[D]		X[D]	X			
12/16/98										X	X	X	F		X	X	X[D]				
12/17/98				X	X	X	X											X[D]			
1/7/99										X	X	X	F		X	X	X	X[D]			
1/14/99				X	X	X	X														
1/27/99	O[W]	X[W]	X[W]																		
2/5/99				X[D]	X	X	X														
2/10/99*									X	X	X	X	X		X	X	X	X			
2/26/99									X	X	X	X	X		X	X	X	X[D]			
3/1/99				X[D]	X	X	X	X[W]													
3/5/99									flow						flow						
3/19/99																			X		
3/31/99				X	X	X[D]	X														
4/2/99									X	X	X	X	X		X	X	X	X[D]			
4/13/99				X	X	X[D]	X														
4/14/99									X	X	X	X	X		X	X	X[D]	X			
4/29/99				O	O	O[D]	O														
5/5/99									O	O	O[D]	O	O		O	O	O	O			
5/19/99				O[D]	O	O	O														
5/21/99									O	O	O	O	O		O[D]		O	O			
5/27/99				O[D]	O	O	O														
5/28/99									O	O	O	O	O	T	O		O	O[D]		T[A]	
6/3/99																		Fe			
6/4/99										F	F	F	F	F[W]	F			flow		F[B]	
6/9/99				O	O	O	O[D]														
6/18/99									X	X	X	X	X	X[Y]	X[D]	X	X	X		X[C W]	
7/2/99															O	O	O	O[D]			
7/6/99																					O[H W]
7/27/99*				X[D]	X	X	X														
8/26/99				X[D]	X	X	X														
9/10/99									X	X	X	X	X		X	X	X	X[D]			
9/19/99														F[W]							

A – Flood-Stanly Recon locations include 9RD (Ramsey Drive), 9MG (Morgan Drift), 9DR (Dull Raise), and 9CV (Cherry Vent Raise)

B – Flood-Stanly Recon locations include 9BX (Bailey Crosscut)

C – Flood-Stanly Recon locations include 10PU (10 Level Pumps).

D – Duplicate samples collected

F – Samples analyzed for field parameters only. Field parameters include temperature, pH, and conductivity. Flow also measured.

Fe – Samples analyzed for dissolved ferrous iron only.

flow – No samples collected, flow measurements only.

H - Hanna Stope locations include 2SU (Sullivan No. 2 Raise), 6DP (Hanna Stope draw point), 6HS (Hanna Stope drainage), and 6PD (Pond before draw points).

* - Field Blank samples were collected on 2/10/99 and 7/27/99 during the sampling program. Commercially prepared HPLC water was poured directly into sample containers or through the filter apparatus for filtered samples. These samples were analyzed for total and dissolved metals, sulfate, TSS, lime demand/solids formed, and dissolved ferrous iron.

W – No flow measurements.

Y – No flow or field measurements (i.e., temperature, pH, and conductivity).

X – Samples analyzed for total and dissolved metals (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Ti, V, Zn), sulfate, TSS, lime demand/solids formed, and dissolved ferrous iron. Field parameters include temperature, pH, and conductivity. Flow also measured.

O – Samples analyzed for total metals (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Ti, V, Zn), sulfate, TSS, lime demand/solids formed, and dissolved ferrous iron. Field parameters include temperature, pH, and conductivity. Flow also measured.

T – Samples analyzed for total metals (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Ti, V, Zn), sulfate, TSS, and lime demand/solids formed. Field parameters include temperature, pH, and conductivity.

3.0 Monitoring Results

The results of the monitoring program (October 1998 through September 1999) are presented in terms of mine water flow and quality. Zinc and lime demand are used as indicator parameters of water quality. Mass balances for recent sampling events (March through September) are conducted to assess the completeness of the monitoring program. Summaries of all field and laboratory data collected (including regularly monitored and spot-sampled locations) are maintained in Excel spreadsheet format and are included as raw data summary in Appendix A.

3.1 Quality Assurance / Quality Control (QA/QC)

The *Health and Safety Plan (HASP) – Bunker Hill Mine Water Management* (CH2M HILL, 1998a) and the *Field Sampling Plan (FSP) – Bunker Hill Mine Water Management* (CH2M HILL, 1998b) were prepared and implemented throughout the sampling program for field activities conducted by field personnel.

Field methods, sampling procedures, sample materials, sample preservation, packaging and transport, field and laboratory quality control and assurance procedures were followed throughout this monitoring program as outlined in the *FSP* (CH2M HILL, 1998b), and in the *Quality Assurance Project Plan (QAPP) – Bunker Hill Mine Water Management* (CH2M HILL, 1998c).

Field duplicate, laboratory QC, and field blank samples were collected at different frequencies per the *FSP* (CH2M HILL, 1998b). Analytical method requirements, and data quality objectives were outlined in the *QAPP* (CH2M HILL, 1998c).

Samples were sent to laboratories in EPA's Contract Laboratory Program (CLP) for metals analysis (total and dissolved) and analyzed per EPA CLP ILM4.0 (CH2M HILL, 1998c). Samples analyzed for sulfate, total suspended solids (TSS), ferrous iron, and lime demand/solids formed were sent to the Columbia Analytical Services, Inc. (CAS) laboratory in Redding, California. The *Sampler's Guide to the Contract Laboratory Program* (EPA) requirements were followed to perform sample preparation, packaging and transport, and sample paperwork for all samples sent to the laboratories for analysis.

Data review, validation, and verification were performed at the laboratory, by the EPA Quality Assurance Management Section, and by the CH2M HILL Quality Assurance Manager. Data review and validation for samples analyzed at CAS laboratory was conducted by CH2M HILL. A *Data Validation Report* for these samples is attached as Appendix B. All data were reported to meet project criteria and to be acceptable per specifications in this *Data Validation Report*. Therefore, no data validation flags were reported.

EPA's Quality Assurance and Data Unit conducted data review and validation for all samples sent to EPA CLP laboratories for total and dissolved metals analyses. These CLP Metals Analysis Data Validation Reports are on file in CH2M HILL's Spokane office and can be made available for review. On several occasions, some reported analytical metals results were not qualified and were flagged as 'unusable.' These were for non-detected Selenium and Thallium results, and the disqualification was due to extremely low matrix spike recovery, or due to suspected iron interference or blank contamination. These 'unusable' analytical results were not included in any analysis, and were noted 'unusable' in the raw data summary sheets. On more frequent occasions, metals analysis results were reported as 'estimated' due to suspected interference and serial dilution results. These results were included in all analyses (refer to the CLP Metals Analysis Data Validation Reports for details).

3.2 Flow

3.2.1 Flow Summary for All Monitoring Locations

A summary of flow data for each regularly monitored location (except for 9S2, which was a late addition to the program) is presented in Figure 1. Flow measurement devices currently in place for each sampling location are summarized in raw data summary Excel worksheets included in Appendix A.

Figure 1 shows that all monitoring locations exhibited an increase in flow in early March. In early April 1999, some locations exhibited a decrease in flow while others continued to rise. These changing flows suggested that snowmelt began in early March, and cooler temperatures in April decreased snowmelt. Monitoring locations that measure flow from sources hydraulically connected to surface water and snowmelt infiltration (5WR, 5BK, 5WM) exhibited an increase in flow in early March. This response was likely due to relatively low-elevation snowmelt. Other monitoring locations that are not directly connected to low level surface water and snowmelt infiltration (9CR and 9SX) exhibited a lag time of approximately 1 month, and flows picked up in early April when the higher elevation snow melted. A memorandum attached in Appendix E describes field observations during high-elevation snowmelt in May.

The most dramatic increase in flow at all locations was demonstrated towards end of May when the higher elevation snowmelt contributed to the flow streams. Flow measurements increased by multiple folds at some locations (9SO, 9CR, 9SX, 9LA, 9KT), while others did not demonstrate any major changes (5WM, 9VR, 9BO), and some had decreasing flows (3HD, 5WR, 5BK). During this period, 9CR, 9SO, 9SX, and 9LA reached their annual peak flows. Observed changes include increases in flow from 18 to 70 gallons per minute (gpm) at 9CR, from 4 to 30 gpm at 9SO, from 38 to 373 gpm at 9SX, and from 505 to 1,190 gpm at 9LA.

Most locations reached base flow conditions in late July or August, similar to flows observed as winter base flow at the beginning of the monitoring program (between November 1998 and February 1999).

3.2.2 9KT Flow Variations

The 9KT flow was measured with a 12-inch Parshall flume during the period of the 1998/1999 mine water sampling program. The instantaneous flow was recorded by a bubble meter on a strip chart that was replaced with a new strip chart every couple of months by

Figure 1

Figure 1
Summary of AMD Flow Data
Bunker Hill Mine Water Management

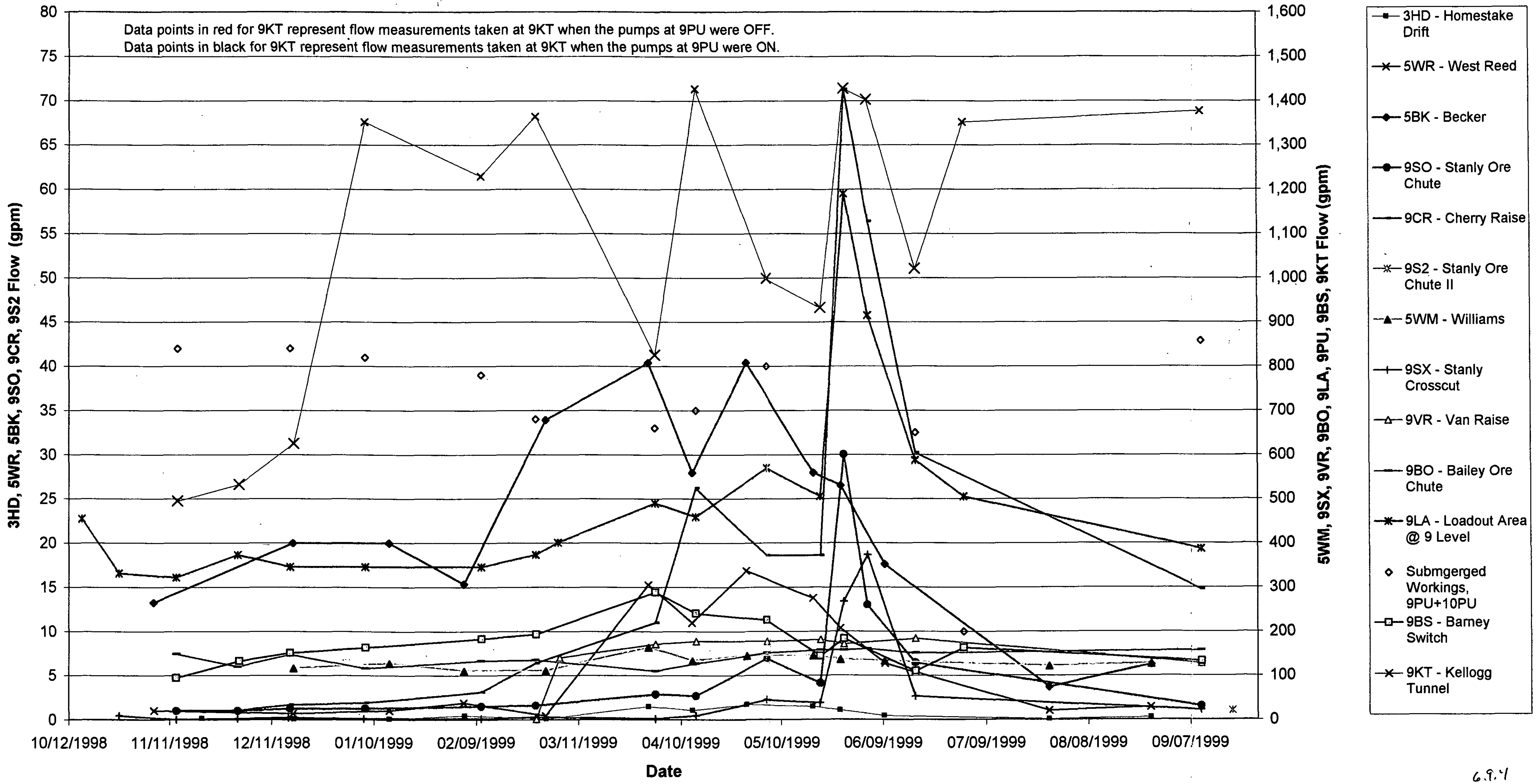

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Figure 2
9KT Instantaneous Flow Measurements (converted to flow in gpm) Recorded by the 9KT Flow Meter Strip Chart

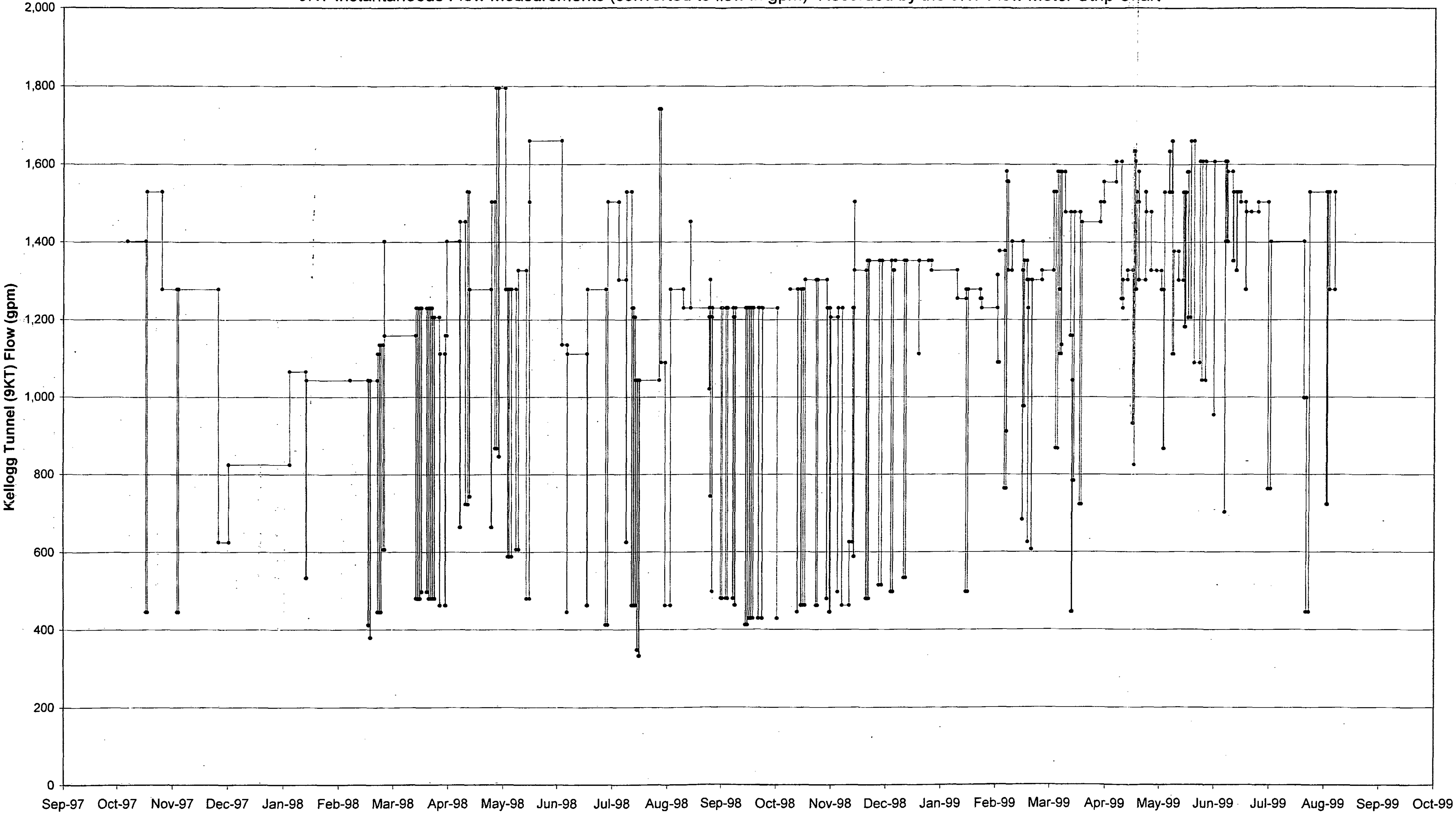
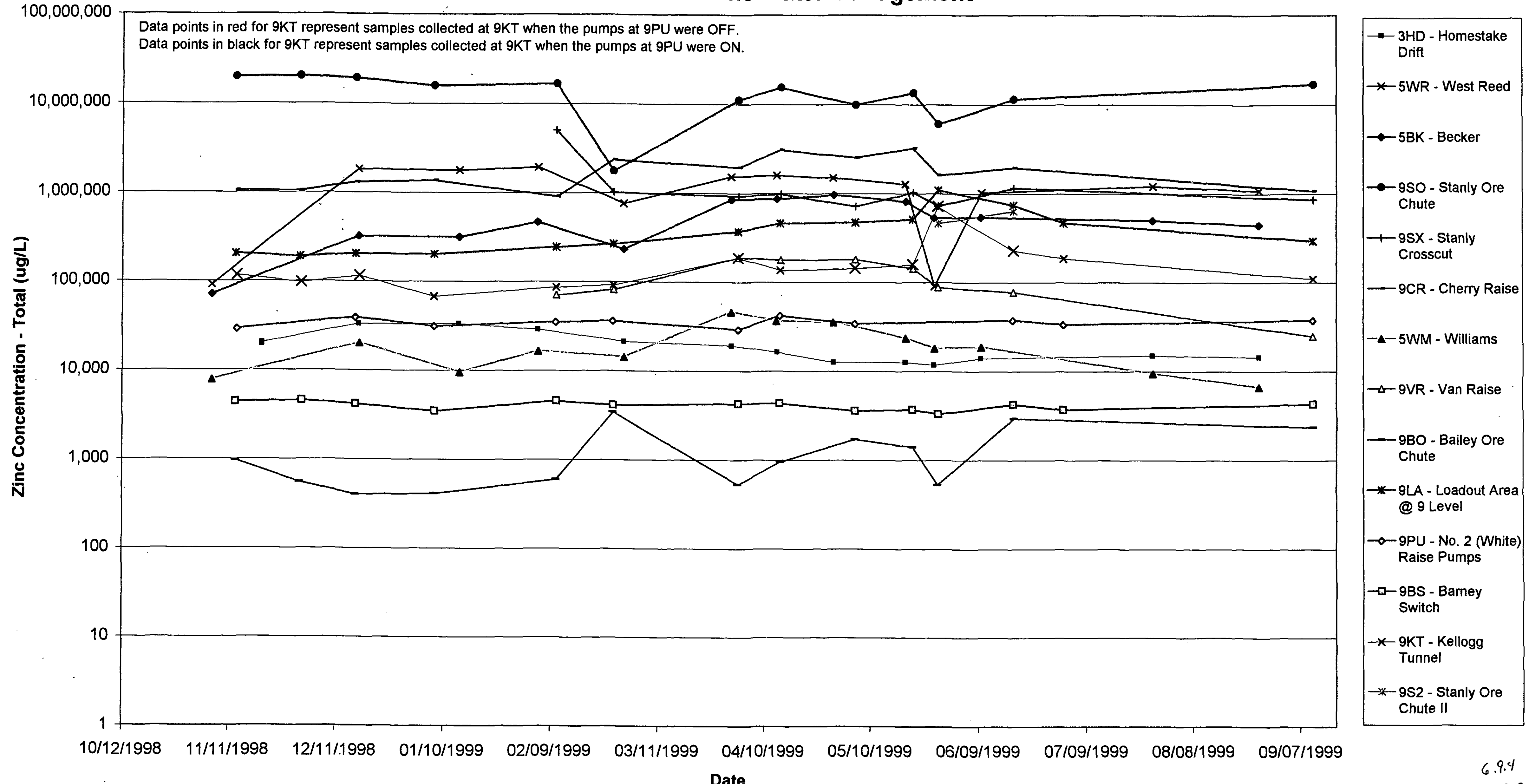


Figure 3
Summary of Analytical Data for Total Zinc
Bunker Hill Mine Water Management



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the Central Treatment Plant (CTP) personnel. Recently, a new flume of the same type and size was installed during pipeline replacement as part of the mine water conveyance system.

Instantaneous data from 9KT varies widely due to 9 and 10 Level pumps (9PU and 10PU) cycling on and off. In addition, travel time for flow out the Kellogg Tunnel (approximately 3 hours per Bob Hopper) makes it difficult to know when the flow at 9KT represents the actual flow condition in the mine. For example, 9PU may be flowing but 9KT may only be measuring the rising portion of the hydrograph. The varying flows pumped or reported by 9PU and/or 10PU (determined as the difference in 9KT flow before and after pumps turn on) may be due to several variables inside and outside of the mine. Some of these are the cleanliness of the flume, the 9KT ditch just upstream of the flume, and the trash rack downstream of the flume. Other potential factors include wood and other debris clogging the screens in the mine pool where the 9PU pumps are located just below 11 Level, adjustment needs for the bubble meter, and excessive flows backing up the water in front of the flume, leading to erroneous readings. A technical memorandum by Bill Hudson (Appendix C) includes a more detailed discussion of possible variables affecting 9KT flow measurements.

Flow variations and different pumping/diversion scenarios of 9BS water also contribute to varying flows at 9KT. Regular operation results in 9BS water flowing into the ditch, which eventually comes out of 9KT. However, sometimes 9BS is pumped out the Kellogg Tunnel to the 9KT instead of reaching 9KT through the ditch. This prevents the better quality 9BS water from mixing with poor quality 9LA water for ditch maintenance purposes. Other times, 9BS was pumped out to the hillsides to go through evaporation units or land-applied.

3.2.3 Submerged Workings Pumps (9PU and 10PU) and Flow Rates

Figure 1 presents flow data from 9KT during both pumping and non-pumping (submerged workings pumps on versus off) scenarios. Data points in red for 9KT represent flow measurements taken at 9KT while the submerged workings pumps (9PU and/or 10PU) were off. Data points in black represent 9KT flow while 9PU and/or 10PU pumps were on. The combined submerged workings pump rate (9PU + 10PU) was calculated using 9KT flow variations on sampling days (pumps on versus off), which ranged between approximately 650 and 850 gpm during the 1999 water year (Figure 1).

The 9KT strip chart instantaneous flow data recorded by the flow meter were converted and entered into an Excel spreadsheet in gpm with sudden significant changes noted. The strip chart recordings (available for the period of November 1997 through September 1999) were used to determine the combined 9PU + 10PU pump rates. Flows recorded at 9KT ranged between 1,200 and 1,650 gpm when the 9PU and/or 10PU pumps were on throughout the 1998/1999 Monitoring Program (November 1998 – September 1999). These flow rates represent winter base flow, and summer peak flow conditions, respectively.

When the submerged workings pumps were turned off, there was a sudden and significant decrease in the strip chart recordings. When 9PU and/or 10PU pumps were off, 9KT flows ranged between 450 gpm during winter base flow and 1,400 gpm during spring peak flow conditions (strip chart readings).

When 9PU and/or 10PU pumps were on, the combined pump contribution to 9KT ranged between 650 and 850 gpm. These rates were calculated by taking the 9KT flow difference when a sudden significant increase or decrease was recorded in 9KT flow readings during the sampling event period.

Figure 2 shows any sudden and significant changes in 9KT instantaneous flow measurements recorded by the strip chart. Between November 1997 and January 1999, the sudden decrease and increase in strip chart readings clearly demonstrate the instances when the 9PU pumps were being turned on and off. Therefore, the 9PU operations were more evident and flow rates were more easily calculated. Starting in February 1999, the pumping system operations have been modified to occasionally throttle 9PU and 10PU pumps, in response to an EPA requirement to keep 9KT flows less than 1,400 to 1,500 gpm due to the partially plugged mine water pipeline. However, no detailed records of these pumping system operations are available. Figure 2 demonstrates the difficulty in distinguishing between periods of pumping versus no pumping scenarios after February 1999.

During four out of five sampling events conducted since the last *Interim Data Summary* in April 1999 (CH2M HILL, 1999c), the 9PU pumps were off when 9KT was sampled. Therefore, the flow and mass contributions from the submerged workings to 9KT were not included in the flow and mass balances.

The 9PU pumps were on during the August 26 and September 10 sampling event. However, no KT flow strip chart data is available beyond September 1 to conduct the flow and mass balances as of the draft finalization of this report. Therefore, for this sampling event, the combined submerged workings (9PU + 10PU) pump rate was determined by forcing 100 percent hydraulic closure at 9KT. This flow rate was calculated to be 858 gpm by subtracting 9LA and 9BS flows from 9KT flow (i.e., 9PU+10PU = 9KT-9LA-9BS).

3.3 Zinc Concentration and Zinc Load

Figure 3 shows the total zinc concentration (log scale) measured at each regularly monitored location. The figure shows that water from the 9SO continuously exhibited the highest concentration of zinc at 0.6 to 2 percent by weight (6,000,000 to 20,000,000 µg/L) throughout the 1998/1999 monitoring program. 9CR, 5WR, and 9SX follow with the next highest zinc concentrations observed among all the monitoring locations. 9CR appears to have the second highest zinc concentration at 0.1 percent to 0.3 percent. 9SX and 5WR also exhibit high zinc concentrations at about 0.1 percent.

The zinc concentration in the submerged workings at 9PU is consistently higher than 3HD, 5WM, 9BS, and 9BO. 9BO consistently exhibits the lowest zinc concentrations out of all monitored locations, second to 9BS.

In general, an increase in flow at smaller locations (9SX, 9SO, 9CR) causes a decrease in zinc concentrations due to dilution effect. However, as flows increase at 9LA and 9KT, the concentrations also go up, thus increasing the overall zinc loads.

The unexpected variations in zinc concentrations (as can be seen in Figure 3) reported for 9SO on February 26, 1999 and for 5WR on May 27, 1999 are suspect due to laboratory dilution procedures or sampling error. However, these reported concentrations were included in analysis for this final data summary memorandum.

Zinc loads were calculated from the flow and zinc concentration data. Figure 4 presents zinc loads for all regularly monitored locations except 3HD. This location was not shown for clarity purposes to separate the other curves on the log scale figure. The zinc load produced by 3HD was less than 0.5 lbs/day throughout the 1998/1999 monitoring program. The figure demonstrates that the majority of zinc load originates from the upper country workings and is measured at 9LA. Zinc load at 9LA for the May 28, 1999 event was 15,581 pounds per day (lb/day). Zinc load at 9KT (12,260 lb/day) is skewed because flows from both pumping and non-pumping scenarios were used in the load calculation. These high zinc loadings at 9LA and 9KT were due to the combined effect of higher flows and higher zinc concentrations observed at these locations in late May.

Major contributors of zinc load to 9LA include 9SO, 9SX, and 9CR (note that all these flows are tributary to 9LA), each loading over 1,000 lb/day during the peak flow period in late May. The submerged workings at 9PU demonstrated a consistent zinc loading of about 300 lb/day throughout the 1999 water year. In general, an increase in zinc loading was observed at most locations during the higher flows in late May. An earlier runoff due to low snowpack runoff and exothermic reactions within the shallow workings causing increased flows had a strong influence on some of these sites.

3.4 Lime Demand and Lime Demand Load

Analytical data for lime demand (calcium hydroxide demand to a pH of 10) are presented in Figure 5. Samples collected from monitoring locations were analyzed for lime demand to assess the strength of AMD from different areas of the mine, and to determine the quantity of lime required to treat a unit volume.

Variations in lime demand values and the trends in Figure 5 are very similar to what was observed with zinc concentrations for all locations in Figure 3. 9SO continuously exhibited the highest lime demand of all the monitoring locations with an average of 470 lb/1,000 gallons. Other locations with high lime demand include 9CR, 5WR, 9SX, and 5BK. The reason for the fluctuation observed at 5WR in late 1998 is not known, but a similar drastic increase was observed during the same period for zinc concentration at 5WR.

Lime demand load is determined from the flow and lime demand data. Figure 6 presents lime demand loads for all locations except 3HD. This location was not shown for clarity purposes to separate the other curves on the log scale figure. The lime demand load produced by 3HD was less than 3 lbs/day throughout the 1998/1999 monitoring program. The figure shows that 9PU contributes the majority of lime demand load measured at 9KT during the winter base flow conditions, and 9LA becomes the major contributor in peak flow summer months. (Again, 9KT lime demand load is low when 9PU pumps are off). The lower country workings (9PU) account for about 6,000 to 12,000 lb/day of lime demand load during low flow winter months, while the upper country workings (measured at 9LA) account for up to 100,000 lb/day of lime demand load during the peak flow season. The high lime demand loadings at 9LA and 9KT were due to the combined effect of higher flows and higher lime demand observed at these locations in late May.

Other big contributors of lime demand load include 9SO, 9SX, and 9CR, each loading up to 1,000 lb/day during the peak flow period in late May. In general, an increase in lime

Figure 4
Summary of Zinc Load
Bunker Hill Mine Water Management

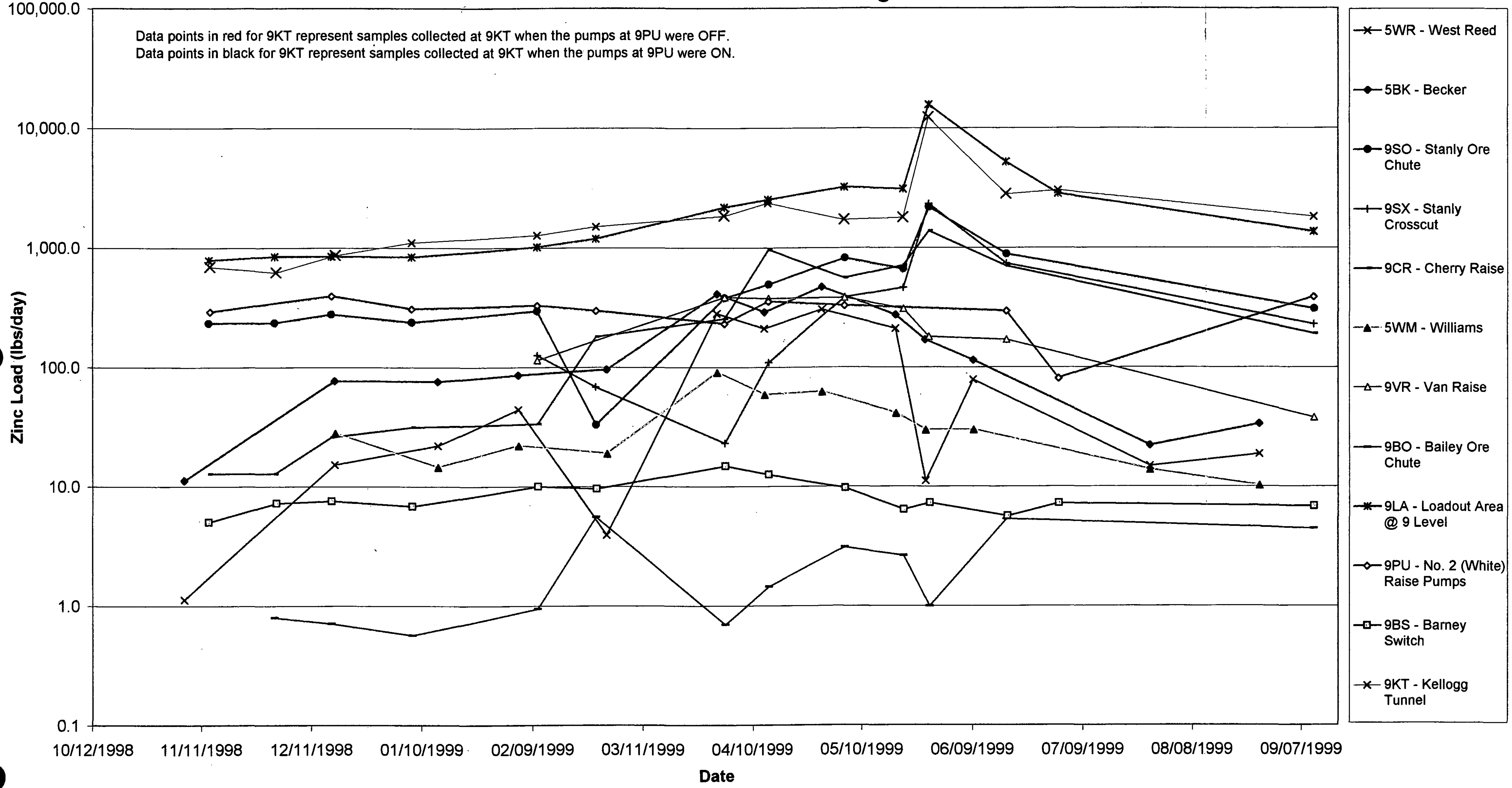

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Figure 5
Summary of Analytical Data for Lime Demand
Bunker Hill Mine Water Management

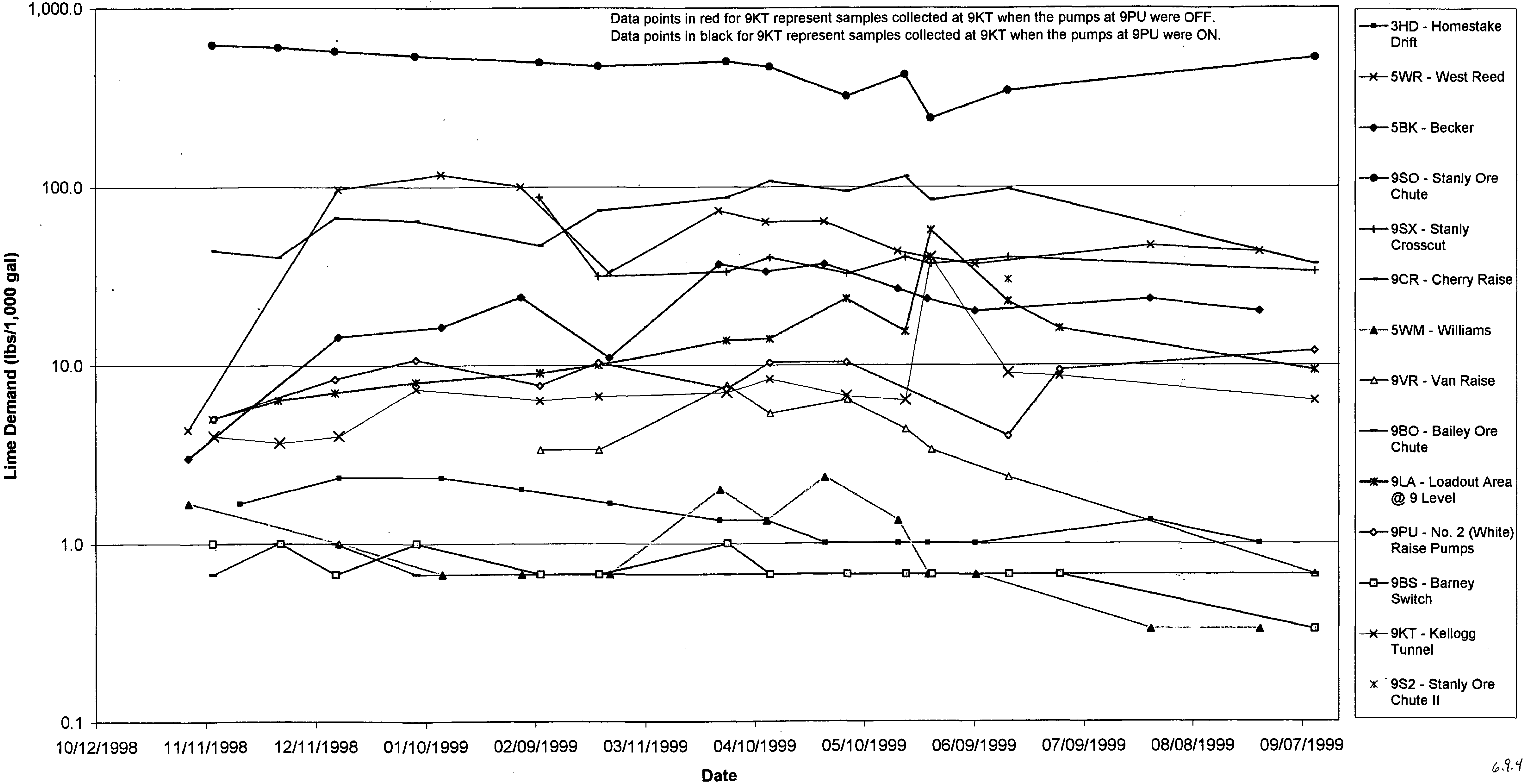

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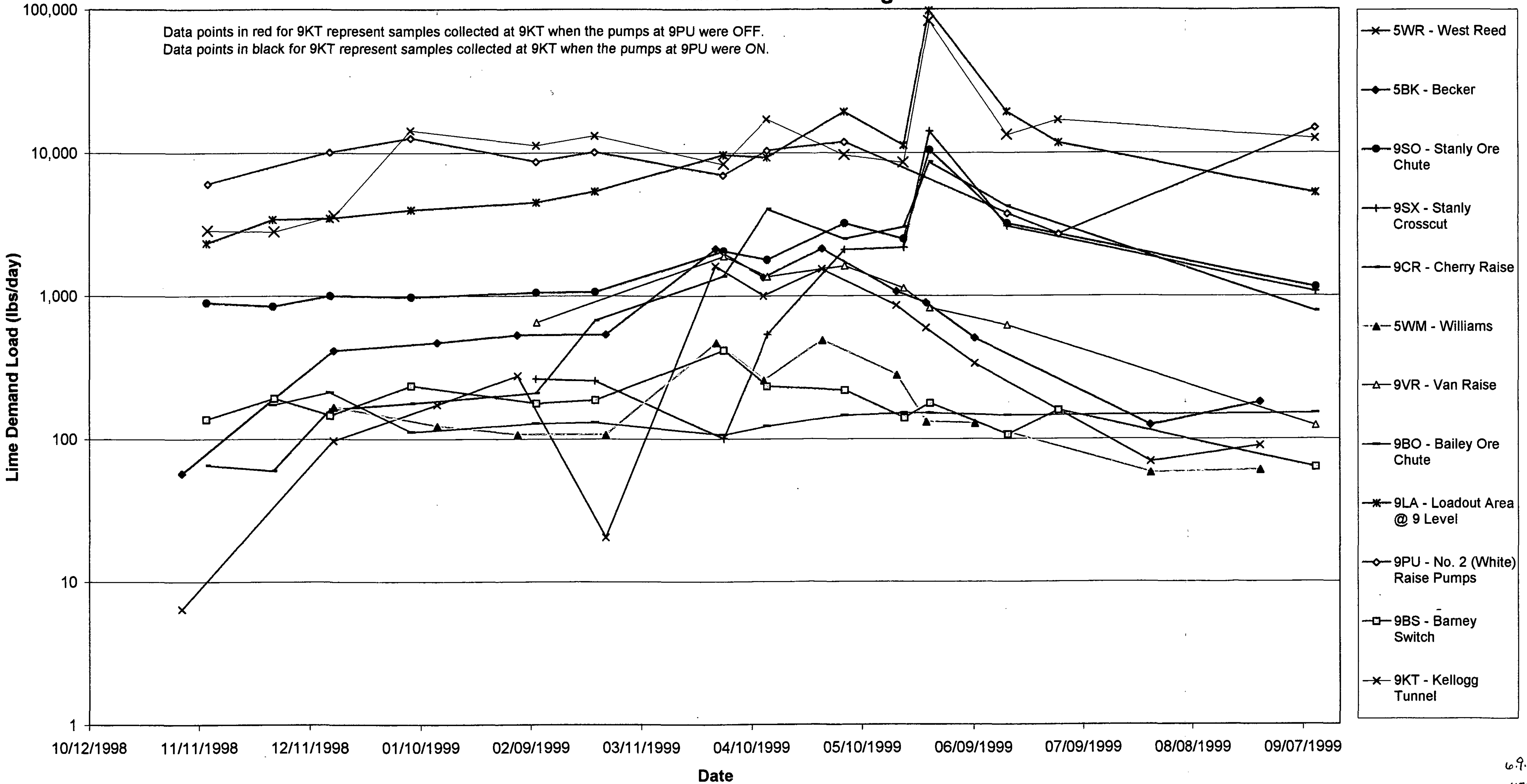
Figure 6
Summary of Lime Demand Load
Bunker Hill Mine Water Management



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demand loading was observed at most locations during the higher flows in late May associated with higher elevation snowmelt. Similar to zinc loading, after reaching peak flows and lime demand earlier in season (March-April), 5BK, 5WR, 5WM, and 3HD exhibit a continuous decreasing trend for lime demand loading during the higher flow spring months, possibly due to dilution effect of higher flows and constant metal loadings.

In general, two parts of snowmelt peaks were observed in the flow and loading figures (Figures 1, 4 and 6); first part was the snowmelt that took place at 5 Level, followed by the second snowmelt peaks observed at 9 Level locations.

3.5 Flow and Mass Balances

Flow and mass balances were conducted on selected monitoring events to determine the closure within the current monitoring network for flow, zinc load, and lime demand load, which were used as indicator parameters of water quality. Iron load and manganese load mass balance closures were also explored to provide additional insight. Data from five events were used to conduct the balances: March 31 and April 2, April 29 and May 5, May 27 and 28, June 9 and 18, and August 26 and September 10 (2 days of fieldwork were required for each monitoring event).

It should be noted that the flow and mass balances do not necessarily close 100 percent, because usually 3 and 5 Level monitoring locations were sampled on different days than 9 Level monitoring locations. In some occasions, there were up to 2 weeks of delay between sampling days for the same sampling event (August 26 and September 10). Therefore, there were variations in flows and metal loadings, which did not close very well. These balances may have closed better if all locations could have been sampled on the same day, taking into consideration the travel times it took for mine water to reach each location. Accuracy of flume measurements, and sampling and/or analytical error may be other factors affecting the mass balance closures.

For the August 26 and September 10 sampling event, the 9PU pumps were on (no record of 10PU operations). Hydraulic closure was forced at 9KT to determine the combined flow rate from the submerged workings (9PU + 10PU), as discussed in detail in Section 3.2.3. However, if 9PU and/or 10PU were being throttled, it is very difficult to establish flow and/or mass balance closure at 9KT. It is not possible to determine the flow contributing to 9KT from the submerged workings, because there is no record of the pump system changes (e.g., pumping or throttling with one or both pumps, what rate of combined flow?, etc.).

3.5.1 March 31 and April 2, 1999 Monitoring Event

Figure 7 presents the balances for flow, zinc, lime demand, iron, and manganese load at each location for the March 31 and April 2 sampling event. Closure is expected within three flow loops ending at 9VR, 9LA, and 9KT. Table 2 summarizes the flow and mass balance percent closures for all three loops.

Figure 7

MASS BALANCES FOR AMD MONITORING NETWORK - 3/31 and 4/2/99 SAMPLING EVENT (PUMPS OFF WHEN 9KT WAS SAMPLED)
BUNKER HILL MINE WATER MANAGEMENT

5WR	Date	Data	%9LA	%9KT
Q	Present	15.3	3.1	1.85
Zn	Present	1,530.0	-	-
Zn L	Present	280.8	12.9	15.2
LD	Present	73.4	-	-
LDL	Present	1,612.3	16.7	19.4
Fe L	Present	427.6	18.8	23.4
Mn L	Present	38.7	7.7	7.1

5BK	Date	Data	%9LA	%9KT
Q	Present	40.4	8.3	4.9
Zn	Present	845.0	-	-
Zn L	Present	410.5	18.9	22.2
LD	Present	36.7	-	-
LDL	Present	2,134.0	22.1	25.6
Fe L	Present	612.2	26.9	33.5
Mn L	Present	57.8	11.4	10.6

9VR	Date	Data	%9LA	%9KT	$\%9VR_{Calc}$
Q	Present	169.7	34.7	20.6	120.0
Zn	Present	187.0	-	-	-
Zn L	Present	381.7	3.6	4.2	131.2
LD	Present	7.7	-	-	-
LDL	Present	1,876.4	19.4	22.5	138.8
Fe L	Present	387.9	17.0	21.2	175.8
Mn L	Present	71.9	14.2	13.1	118.2

5WM	Date	Data	%9LA	%9KT
Q	Present	163.2	33.4	19.8
Zn	Present	46.0	-	-
Zn L	Present	90.3	4.2	4.9
LD	Present	2.0	-	-
LDL	Present	470.1	4.9	5.6
Fe L	Present	69.7	3.1	3.8
Mn L	Present	27.1	5.4	5.0

Q - Flow Rate (gpm)
Zn - Zinc Concentration (mg/L)
Zn L - Zinc Loading (lbs/day)
LD - Lime Demand (lbs/1,000 gal)
LDL - Lime Demand Loading (lbs/day)
Fe L - Iron Loading (lbs/day)
Mn L - Manganese Loading (lbs/day)

$\%9VR_{Calc} = (Q_{5BK} + Q_{5WM})/Q_{9VR}*100$
$\%9LA_{Calc} = (Q_{9VR} + Q_{9CR} + Q_{9BO} + Q_{9SO} + Q_{9SX})/Q_{9LA}*100$
$\%9KT_{Calc} = (Q_{9LA} + Q_{9PU} + Q_{9BS})/Q_{9KT}*100$

Note: 5WR tributary to 5BK,
thus not included in balance

Mass Balance Loop 1:
5BK + 5WM = 9VR

Mass Balance Loop 2:
9VR + 9CR + 9BO + 9SO + 9SX = 9LA

Mass Balance Loop 3:
9LA + 9PU + 9BS = 9KT

9CR	Date	Data	%9LA	%9KT
Q	Present	11.0	2.2	1.3
Zn	Present	1,930.0	-	-
Zn L	Present	254.3	11.7	13.8
LD	Present	86.8	-	-
LDL	Present	1,368.8	14.2	16.4
Fe L	Present	353.1	15.5	19.3
Mn L	Present	47.7	9.4	8.7

9LA	Date	Data	%9KT	$\%9LA_{Calc}$
Q	Present	489.2	59.3	60.5
Zn	Present	369.0	-	-
Zn L	Present	2,172.1	117.7	47.8
LD	Present	13.7	-	-
LDL	Present	9,651.6	115.9	56.9
Fe L	Present	2,278.0	124.7	50.5
Mn L	Present	505.0	92.4	25.0

9BO	Date	Data	%9LA	%9KT
Q	Present	110.4	22.6	13.4
Zn	Present	0.5	-	-
Zn L	Present	0.7	0.03	0.04
LD	Present	0.7	-	-
LDL	Present	106.5	1.1	1.3
Fe L	Present	20.2	0.9	1.1
Mn L	Present	2.1	0.4	0.4

9KT	Date	Data	$\%9KT_{Calc}$
Q	Present	824.9	94.2
Zn	Present	186.0	-
Zn L	Present	1,846.1	118.5
LD	Present	7.0	-
LDL	Present	8,327.0	120.9
Fe L	Present	1,826.2	125.3
Mn L	Present	546.9	101.8

9PU	Date	Data	%9KT
Q	Present	660.0	-
Zn	Present	29.2	-
Zn L	Present	231.9	-
LD	Present	7.3	-
LDL	Present	6,975.9	-
Fe L	Present	721.0	-
Mn L	Present	1,905.8	-

9SO	Date	Data	%9LA	%9KT
Q	Present	2.8	0.6	0.3
Zn	Present	11,100.0	-	-
Zn L	Present	378.1	17.4	20.5
LD	Present	501.0	-	-
LDL	Present	2,042.2	21.2	24.5
Fe L	Present	364.4	16.0	20.0
Mn L	Present	1.2	0.2	0.2

9BS	Date	Data	%9KT
Q	Present	288.1	34.9
Zn	Present	4.3	-
Zn L	Present	14.9	0.8
LD	Present	1.0	-
LDL	Present	414.8	5.0
Fe L	Present	10.4	0.6
Mn L	Present	51.6	9.4

11VD	Date	Data	%9PU	%9KT
Q	Present	-	-	-
Zn	Present	-	-	-
Zn L	Present	-	-	-
LD	Present	-	-	-
LDL	Present	-	-	-
Fe L	Present	-	-	-
Mn L	Present	-	-	-

9SX	Date	Data	%9LA	%9KT
Q	Present	2.1	0.4	0.3
Zn	Present	920.0	-	-
Zn L	Present	23.2	1.1	1.3
LD	Present	33.4	-	-
LDL	Present	100.6	1.0	1.2
Fe L	Present	24.2	1.1	1.3
Mn L	Present	3.5	0.7	0.6

TABLE 2
Flow and Mass Balance Percent Closures for Three Loops on March 31 and April 2, 1999 Monitoring Event
Final Data Summary for the 1998/1999 Monitoring Program - Bunker Hill Mine Water Management

	9VR	9LA	9KT
Q, Flow (gpm)	120%	61%	94%
Zn L, Zinc Loading (lbs/day)	131%	48%	119%
LDL, Lime Demand Loading (lbs/day)	139%	57%	121%
Fe L, Iron Loading (lbs/day)	176%	51%	125%
Mn L, Manganese Loading (lbs/day)	118%	25%	102%

For the first loop (ending at 9VR), 5BK and 5WM provide about 120 percent, 131 percent, 139 percent, 176 percent, and 118 percent of the flow, zinc, lime demand, iron, and manganese load, respectively. Percent closure for flow above 100 percent suggests that part of the flow from the contributors did not reach 9VR (i.e., flow at 9VR is less than combined flow at its contributors). This may be due to loss of flow through fractures along the flow path or due to underestimating the flow at 9VR. Percent closure for metal loads and lime demand load above 100 percent imply that some precipitation may be taking place along the pathways of tributaries flowing towards 9VR, resulting in lower loads measured at 9VR compared to the combined loads from its tributaries.

For the second loop (ending at 9LA), 9VR, 9CR, 9BO, 9SO, and 9SX account for about 61 percent, 48 percent, 57 percent, 51 percent, and 25 percent of the flow, zinc, lime demand, iron, and manganese load, respectively. The zinc load and lime demand load closure at 9LA is similar to what was observed during early and late February sampling events (about 50 percent) presented in *Interim Data Summary* (CH2M HILL, 1999c). Percent flow closure below 100 percent suggests that there may be other potential tributaries to 9LA that were not monitored at the time. Low percent closure at 9LA for metal and lime demand loading indicate that about half of the metal mass is not accounted for, which is likely part of the 39 percent missing flow. The majority of flow originates from 9VR and 9BO, while the majority of metal and lime demand load originates from 9VR, 9CR and 9SO.

Finally, the major tributaries (9LA and 9BS) to 9KT account for 94 percent, 119 percent, 121 percent, 125 percent, and 102 percent of the flow, zinc, lime demand, iron, and manganese load, respectively. 9PU pumps were off at the time of 9KT sampling, therefore they are not included in the 9KT loop closure. The analytical data show that the majority of zinc load, lime demand load, and iron load originated from the upper country workings measured at 9LA.

3.5.2 April 29 and May 5, 1999 Monitoring Event

Figure 8 presents the balances for flow, zinc, lime demand, iron, and manganese load at each location for the April 29 and May 5 sampling event. Table 3 summarizes the flow and mass balance percent closures for all three loops.

Figure 8
MASS BALANCES FOR AMD MONITORING NETWORK - 4/29 and 5/5/99 SAMPLING EVENT (PUMPS OFF WHEN 9KT WAS SAMPLED)
BUNKER HILL MINE WATER MANAGEMENT

5WR	Date	Data	%9LA	%9KT
Q	Present	16.9	3.0	1.69
Zn	Present	1,500.0	-	-
Zn L	Present	304.3	9.5	17.7
LD	Present	63.4	-	-
LDL	Present	1,539.1	8.0	16.0
Fe L	Present	367.1	11.1	13.0
Mn L	Present	31.8	5.3	1.9

5BK	Date	Data	%9LA	%9KT
Q	Present	40.4	7.1	4.0
Zn	Present	962.0	-	-
Zn L	Present	467.4	14.6	27.2
LD	Present	36.7	-	-
LDL	Present	2,134.0	11.1	22.2
Fe L	Present	563.6	17.0	20.0
Mn L	Present	52.0	8.6	3.0

9VR	Date	Data	%9LA	%9KT	$\%9VR_{Calc}$
Q	Present	176.2	30.9	17.7	104.9
Zn	Present	179.0	-	-	-
Zn L	Present	379.5	2.1	3.9	139.4
LD	Present	6.3	-	-	-
LDL	Present	1,608.9	8.4	16.8	162.9
Fe L	Present	326.5	9.9	11.6	188.5
Mn L	Present	63.6	10.5	3.7	106.3

5WM	Date	Data	%9LA	%9KT
Q	Present	144.6	25.4	14.5
Zn	Present	35.5	-	-
Zn L	Present	61.7	1.9	3.6
LD	Present	2.3	-	-
LDL	Present	487.1	2.5	5.1
Fe L	Present	51.8	1.6	1.8
Mn L	Present	15.6	2.6	0.9

Q - Flow Rate (gpm)
Zn - Zinc Concentration (mg/L)
Zn L - Zinc Loading (lbs/day)
LD - Lime Demand (lbs/1,000 gal)
LDL - Lime Demand Loading (lbs/day)
Fe L - Iron Loading (lbs/day)
Mn L - Manganese Loading (lbs/day)

$\%9VR_{Calc} = (Q_{5BK} + Q_{5WM})/Q_{9VR}*100$
$\%9LA_{Calc} = (Q_{9VR} + Q_{9CR} + Q_{9BO} + Q_{9SO} + Q_{9SX})/Q_{9LA}*100$
$\%9KT_{Calc} = (Q_{9LA} + Q_{9PU} + Q_{9BS})/Q_{9KT}*100$

Note: 5WR tributary to 5BK, thus not included in balance

Mass Balance Loop 1:
5BK + 5WM = 9VR

Mass Balance Loop 2:
9VR + 9CR + 9BO + 9SO + 9SX = 9LA

Mass Balance Loop 3:
9LA + 9PU + 9BS = 9KT

9CR	Date	Data	%9LA	%9KT
Q	Present	18.5	3.3	1.9
Zn	Present	2,500.0	-	-
Zn L	Present	558.0	17.4	32.5
LD	Present	93.5	-	-
LDL	Present	2,497.5	13.0	26.0
Fe L	Present	633.8	19.1	22.5
Mn L	Present	75.9	12.6	4.4

9LA	Date	Data	%9KT	$\%9LA_{Calc}$
Q	Present	569.6	57.1	69.8
Zn	Present	468.0	-	-
Zn L	Present	3,207.5	186.8	66.8
LD	Present	23.4	-	-
LDL	Present	19,194.4	199.9	49.7
Fe L	Present	3,310.3	117.3	65.2
Mn L	Present	604.5	35.2	48.9

9BO	Date	Data	%9LA	%9KT
Q	Present	150.7	26.4	15.1
Zn	Present	1.7	-	-
Zn L	Present	3.1	0.1	0.2
LD	Present	0.7	-	-
LDL	Present	145.4	0.8	1.5
Fe L	Present	31.5	1.0	1.1
Mn L	Present	3.5	0.6	0.2

9KT	Date	Data	$\%9KT_{Calc}$
Q	Present	998.0	79.7
Zn	Present	143.0	-
Zn L	Present	1,717.2	187.4
LD	Present	6.7	-
LDL	Present	9,600.2	202.2
Fe L	Present	2,821.9	117.9
Mn L	Present	1,717.2	37.3

9PU	Date	Data	%9KT
Q	Present	800.0	-
Zn	Present	34.1	-
Zn L	Present	328.2	-
LD	Present	10.3	-
LDL	Present	11,865.6	-
Fe L	Present	1,357.2	-
Mn L	Present	3,118.6	-

9SO	Date	Data	%9LA	%9KT
Q	Present	6.9	1.2	0.7
Zn	Present	9,810.0	-	-
Zn L	Present	817.1	25.5	47.6
LD	Present	320.0	-	-
LDL	Present	3,190.2	16.6	33.2
Fe L	Present	684.7	20.7	24.3
Mn L	Present	95.0	15.7	5.5

9BS	Date	Data	%9KT
Q	Present	225.3	22.6
Zn	Present	3.6	-
Zn L	Present	9.7	0.6
LD	Present	0.7	-
LDL	Present	217.4	2.3
Fe L	Present	15.5	0.5
Mn L	Present	35.5	2.1

11VD	Date	Data	%9PU	%9KT
Q	Present	-	-	-
Zn	Present	-	-	-
Zn L	Present	-	-	-
LD	Present	-	-	-
LDL	Present	-	-	-
Fe L	Present	-	-	-
Mn L	Present	-	-	-

9SX	Date	Data	%9LA	%9KT
Q	Present	45.0	7.9	4.5
Zn	Present	712.0	-	-
Zn L	Present	385.5	12.0	22.4
LD	Present	32.4	-	-
LDL	Present	2,099.4	10.9	21.9
Fe L	Present	481.3	14.5	17.1
Mn L	Present	57.4	9.5	3.3

TABLE 3
Flow and Mass Balance Percent Closures for Three Loops on April 29 and May 5, 1999 Monitoring Event
Final Data Summary for the 1998/1999 Monitoring Program - Bunker Hill Mine Water Management

	9VR	9LA	9KT
Q, Flow (gpm)	105%	70%	80%
Zn L, Zinc Loading (lbs/day)	139%	67%	187%
LDL, Lime Demand Loading (lbs/day)	163%	50%	202%
Fe L, Iron Loading (lbs/day)	189%	65%	118%
Mn L, Manganese Loading (lbs/day)	106%	49%	37%

For the first loop (ending at 9VR), 5BK and 5WM provide about 105 percent, 139 percent, 163 percent, 189 percent, and 106 percent of the flow, zinc, lime demand, iron, and manganese load, respectively. Similar implications are present, as with the previous sampling event, for percent closures for metal loads and lime demand load.

For the second loop (ending at 9LA), 9VR, 9CR, 9BO, 9SO, and 9SX account for about 70 percent, 67 percent, 50 percent, 65 percent, and 49 percent of the flow, zinc, lime demand, iron, and manganese load, respectively. The flow, metal load, and lime demand load closures are all better than what was observed in the previous March-April sampling event. However, 30 percent of flow, and 30-50 percent metal load and lime demand load are still not accounted for with the currently monitored tributaries to 9LA. The majority of flow originates from 9VR and 9BO, while the majority of metal and lime demand load originates from 9VR, 9CR, 9SO and 9SX.

Finally, the major tributaries (9LA and 9BS) to 9KT account for 80 percent, 187 percent, 202 percent, 118 percent, and 37 percent of the flow, zinc, lime demand, iron, and manganese load, respectively. The reason for such low percent closure for manganese may be the variation due to the 9PU pumps being off at the time of sampling at 9KT. Contribution from 9PU was not included in the flow and metal load balance calculations at 9KT. Therefore, the majority of flow, metal load, and lime demand load at 9KT originate from the upper country workings measured at 9LA.

The large contributors of flow, metal load, and lime demand load for this event are similar to the previous sampling event discussed above.

3.5.3 May 27 and 28, 1999 Monitoring Event

Figure 9 presents the balances for flow, zinc, lime demand, iron, and manganese load at each location for the May 27 and May 28 sampling event. Table 4 summarizes the flow and mass balance percent closures for all three loops.

Figure 9
MASS BALANCES FOR AMD MONITORING NETWORK - 5/27 and 5/28/99 SAMPLING EVENT
(PUMPS OFF WHEN 9KT WAS SAMPLED; NO 9PU SAMPLES COLLECTED)
BUNKER HILL MINE WATER MANAGEMENT

5WR	Date	Data	%9LA	%9KT
Q	Present	10.3	0.9	0.72
Zn	Present	90.4	-	-
Zn L	Present	11.2	0.1	0.1
LD	Present	40.1	-	-
LDL	Present	595.2	0.6	0.7
Fe L	Present	17.9	0.1	0.1
Mn L	Present	1.8	0.1	0.1

5BK	Date	Data	%9LA	%9KT
Q	Present	26.5	2.2	1.9
Zn	Present	531.0	-	-
Zn L	Present	169.3	1.1	1.4
LD	Present	23.4	-	-
LDL	Present	893.1	0.9	1.1
Fe L	Present	237.2	1.0	1.5
Mn L	Present	27.0	1.1	1.2

9VR	Date	Data	%9LA	%9KT	$\%9VR_{Calc}$
Q	Present	169.7	14.3	11.9	95.6
Zn	Present	87.3	-	-	-
Zn L	Present	178.2	0.1	0.1	111.6
LD	Present	3.3	-	-	-
LDL	Present	816.0	0.8	1.0	125.5
Fe L	Present	162.5	0.7	1.0	160.0
Mn L	Present	42.9	1.7	2.0	89.5

5WM	Date	Data	%9LA	%9KT
Q	Present	135.6	11.4	9.5
Zn	Present	18.1	-	-
Zn L	Present	29.5	0.2	0.2
LD	Present	0.7	-	-
LDL	Present	130.9	0.1	0.2
Fe L	Present	22.7	0.1	0.1
Mn L	Present	11.3	0.5	0.5

Q - Flow Rate (gpm)
Zn - Zinc Concentration (mg/L)
Zn L - Zinc Loading (lbs/day)
LD - Lime Demand (lbs/1,000 gal)
LDL - Lime Demand Loading (lbs/day)
Fe L - Iron Loading (lbs/day)
Mn L - Manganese Loading (lbs/day)

$\%9VR_{Calc} = (Q_{5BK} + Q_{5WM})/Q_{9VR}*100$
$\%9LA_{Calc} = (Q_{9VR} + Q_{9CR} + Q_{9BO} + Q_{9SO} + Q_{9SX})/Q_{9LA}*100$
$\%9KT_{Calc} = (Q_{9LA} + Q_{9PU} + Q_{9BS})/Q_{9KT}*100$

Note: 5WR tributary to 5BK,
thus not included in balance

Mass Balance Loop 1:
5BK + 5WM = 9VR

Mass Balance Loop 2:
9VR + 9CR + 9BO + 9SO + 9SX = 9LA

Mass Balance Loop 3:
9LA + 9PU + 9BS = 9KT

9CR	Date	Data	%9LA	%9KT
Q	Present	71.2	6.0	5.0
Zn	Present	1,600.0	-	-
Zn L	Present	1,370.9	8.8	11.2
LD	Present	83.4	-	-
LDL	Present	8,552.6	8.8	10.4
Fe L	Present	2,159.2	8.9	13.8
Mn L	Present	220.2	8.8	10.0

9LA	Date	Data	%9KT	$\%9LA_{Calc}$
Q	Present	1,189.5	83.4	58.4
Zn	Present	1,090.0	-	-
Zn L	Present	15,599.9	127.1	38.7
LD	Present	56.7	-	-
LDL	Present	97,120.3	117.9	35.0
Fe L	Present	24,187.0	154.5	30.9
Mn L	Present	2,490.3	113.3	25.2

9BO	Date	Data	%9LA	%9KT
Q	Present	156.9	13.2	11.0
Zn	Present	0.5	-	-
Zn L	Present	1.0	0.01	0.01
LD	Present	0.7	-	-
LDL	Present	151.4	0.2	0.2
Fe L	Present	36.1	0.1	0.2
Mn L	Present	3.5	0.1	0.2

9KT	Date	Data	$\%9KT_{Calc}$
Q	Present	1,426.8	96.2
Zn	Present	715.0	-
Zn L	Present	12,274.6	127.2
LD	Present	40.1	-
LDL	Present	82,390.7	118.1
Fe L	Present	15,656.6	154.5
Mn L	Present	2,197.4	114.5

9PU	Date	Data	%9KT
Q	Present	-	-
Zn	Present	-	-
Zn L	Present	-	-
LD	Present	-	-
LDL	Present	-	-
Fe L	Present	-	-
Mn L	Present	-	-

9SO	Date	Data	%9LA	%9KT
Q	Present	30.0	2.5	2.1
Zn	Present	6,010.0	-	-
Zn L	Present	2,169.3	13.9	17.7
LD	Present	240.0	-	-
LDL	Present	10,368.0	10.7	12.6
Fe L	Present	2,385.9	9.9	15.2
Mn L	Present	16.8	0.7	0.8

9BS	Date	Data	%9KT
Q	Present	182.9	12.8
Zn	Present	3.3	-
Zn L	Present	7.3	0.1
LD	Present	0.7	-
LDL	Present	176.5	0.2
Fe L	Present	4.7	0.0
Mn L	Present	26.2	1.2

11VD	Date	Data	%9PU	%9KT
Q	Present	-	-	-
Zn	Present	-	-	-
Zn L	Present	-	-	-
LD	Present	-	-	-
LDL	Present	-	-	-
Fe L	Present	-	-	-
Mn L	Present	-	-	-

9SX	Date	Data	%9LA	%9KT
Q	Present	267.0	22.4	18.7
Zn	Present	721.0	-	-
Zn L	Present	2,316.2	14.8	18.9
LD	Present	36.7	-	-
LDL	Present	14,110.4	14.5	17.1
Fe L	Present	2,730.6	11.3	17.4
Mn L	Present	343.7	13.8	15.6

TABLE 4
Flow and Mass Balance Percent Closures for Three Loops on May 27 and 28, 1999 Monitoring Event
Final Data Summary for the 1998/1999 Monitoring Program - Bunker Hill Mine Water Management

	9VR	9LA	9KT
Q, Flow (gpm)	96%	58%	96%
Zn L, Zinc Loading (lbs/day)	112%	39%	127%
LDL, Lime Demand Loading (lbs/day)	126%	35%	118%
Fe L, Iron Loading (lbs/day)	160%	31%	155%
Mn L, Manganese Loading (lbs/day)	90%	25%	115%

For the first loop (ending at 9VR), 5BK and 5WM provide about 96 percent, 112 percent, 126 percent, 160 percent, and 90 percent of the flow, zinc, lime demand, iron, and manganese load, respectively. Similar implications are present, as with the March-April sampling event, for percent closures for flow, metal loads, and lime demand load.

For the second loop (ending at 9LA), 9VR, 9CR, 9BO, 9SO, and 9SX account for about 58 percent, 39 percent, 35 percent, 31 percent, and 25 percent of the flow, zinc, lime demand, iron, and manganese load, respectively. The flow, metal load, and lime demand load closures are not as good as what was observed in the March-April sampling event. About 40 percent of flow, and 60-75 percent metal load and lime demand load are still not accounted for with the currently monitored tributaries to 9LA during this sampling event. The majority of flow originates from 9VR and 9BO, while the majority of metal and lime demand load originates from 9VR, 9CR, 9SO and 9SX.

Finally, the major tributaries (9LA and 9BS) to 9KT account for 96 percent, 127 percent, 118 percent, 155 percent, and 115 percent of the flow, zinc, lime demand, iron, and manganese load, respectively. No samples were collected at 9PU during this event, because No. 2 Raise Pumps were off at the time of sampling. Therefore, contribution from 9PU was not included in the flow, metal load, and lime demand load balance calculations at 9KT. Subsequently, the majority of flow, metal load, and lime demand load at 9KT originated from the upper country workings measured at 9LA.

3.5.4 June 9 and 18, 1999 Monitoring Event

Figure 10 presents the balances for flow, zinc, lime demand, iron, and manganese load at each location for the June 9 and 18 sampling event. Table 5 summarizes the flow and mass balance percent closures for all three loops.

Figure 10
MASS BALANCES FOR AMD MONITORING NETWORK - 6/9 and 6/18/99 SAMPLING EVENT (PUMPS OFF WHEN 9KT WAS SAMPLED)
BUNKER HILL MINE WATER MANAGEMENT

5WR	Date	Data	%9LA	%9KT
Q	Present	6.4	1.1	0.63
Zn	Present	1,020.0	-	-
Zn L	Present	78.3	1.5	2.8
LD	Present	36.7	-	-
LDL	Present	337.1	1.8	2.5
Fe L	Present	99.0	2.1	4.4
Mn L	Present	11.9	1.5	0.9

5BK	Date	Data	%9LA	%9KT
Q	Present	17.6	3.0	1.7
Zn	Present	539.0	-	-
Zn L	Present	114.0	2.2	4.1
LD	Present	20.0	-	-
LDL	Present	506.3	2.6	3.8
Fe L	Present	140.2	3.0	6.3
Mn L	Present	18.7	2.3	1.5

9VR	Date	Data	%9LA	%9KT	$\%9VR_{Calc}$
Q	Present	182.9	31.2	17.9	82.2
Zn	Present	76.6	-	-	-
Zn L	Present	168.6	0.6	1.0	85.3
LD	Present	2.3	-	-	-
LDL	Present	616.3	3.2	4.7	102.9
Fe L	Present	120.4	2.6	5.4	134.0
Mn L	Present	48.9	6.0	3.9	62.1

5WM	Date	Data	%9LA	%9KT
Q	Present	132.7	22.6	13.0
Zn	Present	18.7	-	-
Zn L	Present	29.9	0.6	1.1
LD	Present	0.7	-	-
LDL	Present	128.0	0.7	1.0
Fe L	Present	21.1	0.4	0.9
Mn L	Present	11.7	1.4	0.9

Q - Flow Rate (gpm)
Zn - Zinc Concentration (mg/L)
Zn L - Zinc Loading (lbs/day)
LD - Lime Demand (lbs/1,000 gal)
LDL - Lime Demand Loading (lbs/day)
Fe L - Iron Loading (lbs/day)
Mn L - Manganese Loading (lbs/day)

$\%9VR_{Calc} = (Q_{5BK} + Q_{5WM})/Q_{9VR}*100$

$\%9LA_{Calc} = (Q_{9VR} + Q_{9CR} + Q_{9BO} + Q_{9SO} + Q_{9SX})/Q_{9LA}*100$

$\%9KT_{Calc} = (Q_{9LA} + Q_{9PU} + Q_{9BS})/Q_{9KT}*100$

Note: 5WR tributary to 5BK, thus not included in balance

Mass Balance Loop 1:
5BK + 5WM = 9VR

Mass Balance Loop 2:
9VR + 9CR + 9BO + 9SO + 9SX = 9LA

9CR	Date	Data	%9LA	%9KT
Q	Present	30.2	5.1	3.0
Zn	Present	1,930.0	-	-
Zn L	Present	700.9	13.5	25.0
LD	Present	96.8	-	-
LDL	Present	4,207.5	22.0	31.8
Fe L	Present	751.8	16.0	33.6
Mn L	Present	109.3	13.5	8.6

9LA	Date	Data	%9KT	$\%9LA_{Calc}$
Q	Present	586.4	57.5	72.2
Zn	Present	738.0	-	-
Zn L	Present	5,206.8	186.0	47.8
LD	Present	22.7	-	-
LDL	Present	19,167.6	144.8	58.5
Fe L	Present	4,691.7	210.0	46.1
Mn L	Present	811.4	64.2	30.9

9BO	Date	Data	%9LA	%9KT
Q	Present	150.7	25.7	14.8
Zn	Present	2.9	-	-
Zn L	Present	5.3	0.1	0.2
LD	Present	0.7	-	-
LDL	Present	145.4	0.8	1.1
Fe L	Present	39.5	0.8	1.8
Mn L	Present	4.5	0.6	0.4

Mass Balance Loop 3:
9LA + 9PU + 9BS = 9KT

9KT	Date	Data	$\%9KT_{Calc}$
Q	Present	1,020.5	68.3
Zn	Present	228.0	-
Zn L	Present	2,799.4	186.2
LD	Present	9.0	-
LDL	Present	13,239.8	145.6
Fe L	Present	2,234.6	210.1
Mn L	Present	1,264.6	65.7

9PU	Date	Data	%9KT
Q	Present	650.0	-
Zn	Present	37.6	-
Zn L	Present	294.1	-
LD	Present	4.0	-
LDL	Present	3,753.4	-
Fe L	Present	356.6	-
Mn L	Present	1,008.9	-

9SO	Date	Data	%9LA	%9KT
Q	Present	6.4	1.1	0.6
Zn	Present	11,400.0	-	-
Zn L	Present	882.0	16.9	31.5
LD	Present	344.0	-	-
LDL	Present	3,185.2	16.6	24.1
Fe L	Present	639.0	13.6	28.6
Mn L	Present	2.7	0.3	0.2

9BS	Date	Data	%9KT
Q	Present	110.4	10.8
Zn	Present	4.3	-
Zn L	Present	5.6	0.2
LD	Present	0.7	-
LDL	Present	106.5	0.8
Fe L	Present	2.9	-
Mn L	Present	19.3	-

11VD	Date	Data	%9PU	%9KT
Q	Present	-	-	-
Zn	Present	-	-	-
Zn L	Present	-	-	-
LD	Present	-	-	-
LDL	Present	-	-	-
Fe L	Present	-	-	-
Mn L	Present	-	-	-

9SX	Date	Data	%9LA	%9KT
Q	Present	53.1	9.1	5.2
Zn	Present	1,150.0	-	-
Zn L	Present	734.6	14.1	26.2
LD	Present	40.1	-	-
LDL	Present	3,065.9	16.0	23.2
Fe L	Present	610.7	13.0	27.3
Mn L	Present	85.6	10.6	6.8

TABLE 5
Flow and Mass Balance Percent Closures for Three Loops on June 9 and 18, 1999 Monitoring Event
Final Data Summary for the 1998/1999 Monitoring Program - Bunker Hill Mine Water Management

	9VR	9LA	9KT
Q, Flow (gpm)	82%	72%	68%
Zn L, Zinc Loading (lbs/day)	85%	48%	186%
LDL, Lime Demand Loading (lbs/day)	103%	59%	146%
Fe L, Iron Loading (lbs/day)	134%	46%	210%
Mn L, Manganese Loading (lbs/day)	62%	31%	66%

For the first loop (ending at 9VR), 5BK and 5WM provide about 82 percent, 85 percent, 103 percent, 134 percent, and 62 percent of the flow, zinc, lime demand, iron, and manganese load, respectively. Similar implications are present, as with the March-April sampling event, for percent closures for flow, metal loads, and lime demand load.

For the second loop (ending at 9LA), 9VR, 9CR, 9BO, 9SO, and 9SX account for about 72 percent, 48 percent, 59 percent, 46 percent, and 31 percent of the flow, zinc, lime demand, iron, and manganese load, respectively. The flow, metal load, and lime demand load closures are similar to what was observed in the March-April sampling event. About 30 percent of flow, and 40-70 percent metal load and lime demand load are still not accounted for with the currently monitored tributaries to 9LA. The majority of flow originates from 9VR and 9BO, while the majority of metal and lime demand load originates from 9CR, 9SO and 9SX.

Finally, the major tributaries (9LA and 9BS) to 9KT account for 68 percent, 186 percent, 146 percent, 210 percent, and 66 percent of the flow, zinc, lime demand, iron, and manganese load, respectively. The reason for such low percent closure for manganese may be the variation due to the 9PU pumps being off at the time of sampling at 9KT. Contribution from 9PU was not included in the flow and metal load balance calculations at 9KT. Therefore, the majority of flow, metal load, and lime demand load at 9KT originate from the upper country workings measured at 9LA.

The large contributors of flow, metal load, and lime demand load for this event are similar to the March-April sampling event discussed earlier.

3.5.5 August 26 and September 10, 1999 Monitoring Event

Figure 11 presents the balances for flow, zinc, lime demand, iron, and manganese load at each location for the August 26 and September 10 sampling event. Table 6 summarizes the flow and mass balance percent closures for all three loops.

Figure 11
MASS BALANCES FOR AMD MONITORING NETWORK - 8/26 and 9/10/99 SAMPLING EVENT (PUMPS ON WHEN 9KT WAS SAMPLED)
BUNKER HILL MINE WATER MANAGEMENT

5WR	Date	Data	%9LA	%9KT
Q	Present	1.4	0.4	0.1
Zn	Present	1,080.0	-	-
Zn L	Present	18.7	1.4	1.0
LD	Present	43.4	-	-
LDL	Present	89.8	1.7	0.7
Fe L	Present	27.8	2.1	1.1
Mn L	Present	3.7	1.3	0.1

5BK	Date	Data	%9LA	%9KT
Q	Present	6.3	1.6	0.5
Zn	Present	442.0	-	-
Zn L	Present	33.4	2.5	1.8
LD	Present	20.0	-	-
LDL	Present	180.8	3.5	1.4
Fe L	Present	45.8	3.5	1.7
Mn L	Present	6.9	2.3	0.2

9VR	Date	Data	%9LA	%9KT	%9VR$_{Calc}$
Q	Present	126.9	32.9	9.2	104.9
Zn	Present	24.6	-	-	-
Zn L	Present	37.6	0.7	0.5	115.9
LD	Present	0.7	-	-	-
LDL	Present	122.5	2.4	1.0	196.9
Fe L	Present	24.1	1.9	0.9	239.7
Mn L	Present	23.2	7.9	0.6	56.8

5WM	Date	Data	%9LA	%9KT
Q	Present	126.9	32.9	9.2
Zn	Present	6.7	-	-
Zn L	Present	10.2	0.7	0.6
LD	Present	0.3	-	-
LDL	Present	60.3	1.2	0.5
Fe L	Present	12.1	0.9	0.5
Mn L	Present	6.3	2.1	0.2

Q - Flow Rate (gpm)
Zn - Zinc Concentration (mg/L)
Zn L - Zinc Loading (lbs/day)
LD - Lime Demand (lbs/1,000 gal)
LDL - Lime Demand Loading (lbs/day)
Fe L - Iron Loading (lbs/day)
Mn L - Manganese Loading (lbs/day)

$\%9VR_{Calc} = (Q_{5BK} + Q_{5WM})/Q_{9VR}*100$
$\%9LA_{Calc} = (Q_{9VR} + Q_{9CR} + Q_{9BO} + Q_{9SO} + Q_{9SX})/Q_{9LA}*100$
$\%9KT_{Calc} = (Q_{9LA} + Q_{9PU} + Q_{9BS})/Q_{9KT}*100$

Note: 5WR tributary to 5BK,
thus not included in balance

Mass Balance Loop 1:
5BK + 5WM = 9VR

Mass Balance Loop 2:
9VR + 9CR + 9BO + 9SO + 9SX = 9LA

Mass Balance Loop 3:
9LA + 9PU + 9BS = 9KT

9CR	Date	Data	%9LA	%9KT
Q	Present	14.7	3.8	1.1
Zn	Present	1,070.0	-	-
Zn L	Present	189.7	14.0	10.4
LD	Present	36.7	-	-
LDL	Present	778.7	15.0	6.2
Fe L	Present	211.0	16.2	8.1
Mn L	Present	37.6	12.7	0.9

9LA	Date	Data	%9KT	%9LA$_{Calc}$
Q	Present	386.1	28.0	83.5
Zn	Present	292.0	-	-
Zn L	Present	1,356.6	74.5	56.4
LD	Present	9.4	-	-
LDL	Present	5,198.9	41.4	62.8
Fe L	Present	1,300.8	49.7	53.2
Mn L	Present	295.5	7.3	32.7

9BO	Date	Data	%9LA	%9KT
Q	Present	156.9	40.6	11.4
Zn	Present	2.4	-	-
Zn L	Present	4.4	0.3	0.2
LD	Present	0.7	-	-
LDL	Present	151.4	2.9	1.2
Fe L	Present	37.4	2.9	1.4
Mn L	Present	4.6	1.5	0.1

9KT*	Date	Data	%9KT$_{Calc}$
Q	Present	1,376.6	100.0
Zn	Present	110.0	-
Zn L	Present	1,822.0	96.1
LD	Present	6.3	-
LDL	Present	12,568.1	159.8
Fe L	Present	2,617.0	114.1
Mn L	Present	4,041.5	105.1

* Forced Hydraulic
closure at 9KT
i.e., 9PU = 9KT - 9LA - 9BS

9PU	Date	Data	%9KT
Q	Present	858.0	62.3
Zn	Present	37.5	-
Zn L	Present	387.1	21.2
LD	Present	12.0	-
LDL	Present	14,826.2	118.0
Fe L	Present	1,682.7	64.3
Mn L	Present	3,933.2	97.3

9SO	Date	Data	%9LA	%9KT
Q	Present	1.5	0.4	0.1
Zn	Present	16,800.0	-	-
Zn L	Present	305.2	22.5	16.8
LD	Present	527.0	-	-
LDL	Present	1,145.9	22.0	9.1
Fe L	Present	208.9	16.1	8.0
Mn L	Present	0.6	0.2	0.0

9BS	Date	Data	%9KT
Q	Present	132.7	9.6
Zn	Present	4.3	-
Zn L	Present	6.8	0.4
LD	Present	0.3	-
LDL	Present	63.1	0.5
Fe L	Present	3.8	-
Mn L	Present	18.2	-

11VD	Date	Data	%9PU	%9KT
Q	Present	-	-	-
Zn	Present	-	-	-
Zn L	Present	-	-	-
LD	Present	-	-	-
LDL	Present	-	-	-
Fe L	Present	-	-	-
Mn L	Present	-	-	-

9SX	Date	Data	%9LA	%9KT
Q	Present	22.2	5.8	1.6
Zn	Present	854.0	-	-
Zn L	Present	228.2	16.8	12.5
LD	Present	33.4	-	-
LDL	Present	1,068.0	20.5	8.5
Fe L	Present	210.3	16.2	8.0
Mn L	Present	30.7	10.4	0.8

TABLE 6
Flow and Mass Balance Percent Closures for Three Loops on August 26 and September 10, 1999 Monitoring Event
Final Data Summary for the 1998/1999 Monitoring Program - Bunker Hill Mine Water Management

	9VR	9LA	9KT
Q, Flow (gpm)	105%	84%	100%
Zn L, Zinc Loading (lbs/day)	116%	56%	96%
LDL, Lime Demand Loading (lbs/day)	197%	63%	160%
Fe L, Iron Loading (lbs/day)	240%	53%	114%
Mn L, Manganese Loading (lbs/day)	57%	33%	105%

For the first loop (ending at 9VR), 5BK and 5WM provide about 105 percent, 116 percent, 197 percent, 240 percent, and 57 percent of the flow, zinc, lime demand, iron, and manganese load, respectively. Similar implications are present, as with the March-April sampling event for percent closures for flow, metal loads, and lime demand load.

For the second loop (ending at 9LA), 9VR, 9CR, 9BO, 9SO, and 9SX account for about 84 percent, 56 percent, 63 percent, 53 percent, and 33 percent of the flow, zinc, lime demand, iron, and manganese load, respectively. The metal load and lime demand load closures are similar to what was observed in the March-April sampling event. About 16 percent of flow, and 40-70 percent metal load and lime demand load are still not accounted for with the currently monitored tributaries to 9LA. The majority of flow originates from 9VR and 9BO, while the majority of metal and lime demand load originates from 9CR, 9SO and 9SX.

Finally, the major tributaries (9LA, 9PU, and 9BS) to 9KT account for 100 percent, 96 percent, 160 percent, 114 percent, and 105 percent of the flow, zinc, lime demand, iron, and manganese load, respectively. Hydraulic closure was forced at 9KT for this monitoring event to determine the combined flow rate from the submerged workings (9PU+10PU), as discussed in detail in Section 3.2.3. The percent closure at 9KT for all balances is much better than those obtained for the high flow spring/summer months. As the flows decrease to winter base flow conditions and the flow variations become less influential, the balances close with higher percentage (similar to better-balanced early and late February closures at 9KT).

Contribution from 9PU was also included in the flow and metal load balance calculations at 9KT, because No. 2 Raise Pumps were on at the time of sampling. Inclusion of 9PU flow may have also contributed to better-balanced closures at 9KT.

3.6 Past and Present Flow and Zinc Loading Comparison

Flow and zinc loading comparisons to past data collected by John Riley and others in the 1980s are also included in this document. The first interim data summary, *Interim Data Evaluation, Bunker Hill Mine Water 1998/1999 Sampling Program* (CH2M HILL, 1999c), concluded that there was close agreement between historic and present data sets during the winter months.

Figures in Appendix D summarize and compare flow and zinc loading for different water years. The data have been obtained from the 1998/1999 AMD Monitoring Program (water year, or WY 1999), Riley's Dissertation (Riley, 1990) (WY 1983, 1984, and 1985), and Bretherton's Master Thesis (Bretherton, 1989) (WY 1986, 1987, and 1988).

Appendix D also contains a memorandum from John Riley/Pyrite Hydrochem on evaluation and interpretation of past and present data comparisons. Riley's memorandum summarizes similarities and differences that were observed in flow and zinc loading for different mine levels (3, 5, and 9 Levels).

The comparison of past and present data shows that the base and peak flows at 5BK, 5WM, 9BS, 9BO and the timing for peak flows at 3HD, 5WR are very similar to the historic records. This suggests that recharge and inflow mechanisms to the mine have not changed substantially in recent years. However, the 1999 peak flows are much higher than the historic records for the Flood Stanly ore body locations (e.g., 9CR, 9SX, 9SO, and 9LA). Peak flows through and from the Flood Stanly ore body increased by a factor of 2 to 12 compared to those of the mid 1980's. The timing of these increased flows coincides with the onset of high elevation snowmelt and recharge via the West Fork of Milo Creek, and infiltration below the Phil Sheridan Raise No. 2.

For most monitoring locations, similar observations have been made for zinc loading as for flow quantities. The zinc loading at 5BK, 5WM, 9BS, 9BO and the timing for peak loads at 3HD, 5WR are very similar to the historic records. Loading through and from the Flood Stanly ore body has increased by a factor of zero to 3.5, which is substantially less than the observed increase in flow quantities. For a more detailed discussion on interpretation of past and present data comparisons, refer to Appendix D.

4.0 Summary

The key objectives of the 1998/1999 monitoring program were met as described below:

- The monitoring program assisted in evaluation of current conditions to determine any significant changes that may have occurred since the last mine water evaluation conducted in the mid-1980s by John Riley and other University of Idaho researchers. Flow and metal load comparisons were conducted to establish a better understanding of past and current conditions within the mine. Similar flow and metal load conditions were observed at the major contributing locations that were monitored in the past, with the exception of significant flow and load increase during peak snowmelt for 9LA and some tributaries.
- The 1998/1999 monitoring program was successful in providing a better understanding of water quality and quantity conditions in the Bunker Hill Mine. A variety of flow and load sources were investigated and the major contributors were identified during this monitoring program.
- The monitoring program also supported the identification and assessment of potential AMD generation mitigation measures, AMD collection, conveyance, and storage measures, and AMD treatment measures.

Based on the information presented in this report, other conclusions that can be drawn are:

- The QA/QC procedures were performed per the *FSP* (CH2M HILL, 1998b) and the *QAPP* (CH2M HILL, 1998c). All data were validated, except for several outliers that were identified.
- Two parts of snowmelt periods were observed in the flow hydrographs; first at 5 Level, then at 9 Level.
- 9SO and 9SX were identified as the major contributors of poor quality water (high metal loads and lime demand) to 9LA, even though the flow contribution was minimal compared to other tributaries.
- 9PU was observed to contribute the majority of lime demand load measured at 9KT during the winter base flow conditions, and 9LA became the major contributor in peak flow summer months. The lower country workings (9PU) accounted for about 6,000 to 12,000 lb/day of lime demand load during low flow winter months, while the upper country workings (measured at 9LA) accounted for up to 100,000 lb/day of lime demand load during the peak flow season.
- The water quality at 9BO was determined to be the best compared to the water quality collected at other monitoring locations.
- The flow and mass balance closures indicated that 15 percent to 40 percent of flow and 30 percent to 75 percent of the metal loading at 9LA was not accounted for due to possible reasons discussed earlier.
- Additional information on average annual flows and water quality parameters that may be used in the design of a treatment plant were collected during this monitoring program.

5.0 Recommendations

Table 2 identifies the key monitoring locations that will be required to assess mitigation effectiveness. These mitigation measures are currently being screened, and may be implemented in the future. The key monitoring locations include regularly monitored locations in the 1998/1999 program in addition to other underground (7 and 8 Level, 11VD, Mine Pool) and surface (West Fork, South Fork, Deadwood Creek, Phil Sheridan Drift, Piezometers, and Upper Division) locations. A TMDL compliance evaluation memorandum will be prepared in February 2000 that will discuss various mitigation measures in more detail.

Based on the information presented in this data summary, it is recommended that the AMD monitoring program be continued in 2000 with additional improvements summarized in Table 7 for future monitoring. The 2000 monitoring locations should include in-mine and surface locations, diversions, streams, and piezometers that have recently been installed. Continued monitoring at these locations will provide information to help assess performance and effectiveness of mitigation measures that are currently being screened, and that may be implemented in the future. Based on the infiltration mitigations that may be constructed, addition or elimination of new/current monitoring locations is also recommended as needed.

It is also recommended that each monitoring location be sampled on the same day. This will reduce temporal uncertainty.

TABLE 7 - Monitoring Locations Required to Assess Effectiveness of Potential Mitigations
Bunker Hill Mine Water Management Project

Location	West Fork	Phil Sheridan Raises	West Fork Diversion	P.S. Raises + W.F. Diversion	Surface Diversions above Guy Cave	Backfill Homestake/Utz	South Fork	South Fork Diversion	Mainstem	Plug Small Hopes	Replace Bunker Hill Dam	Improve Existing Diversion	Deadwood	Inez Shaft	Other	Drillholes	Comment
3 Level																	
3HD								X									Staff gauges in ponds proposed.
3HD2						X		X									A second flume is proposed to measure total Homestake flows.
5 Level																	
5BK								X		X	X	X					
5WM								X			X	X				X	
5WR						X		O				O					
9 Level																	
9VR						X		X		X	X	X				X	Allows mass balances
9SO		X	X	X	X												
9S2		X	X	X	X												
9SX		X	X	X	X												
9BO																X	
9CR		X	X	X	X												
9LA		X	X	X	X	O		X		O	O	O				X	Allows mass balances
9PU		O	O	O	O	O		O		O	O	O		O		O	
9BS														X			
9KT		X	X	X	X	O		X		O	O	O		X		X	
Other Underground Locations																	
7 & 8 LVL Locations		X	X	X	X											O	7 LVL Dam, flumes proposed on these levels to isolate tributaries of 9S2.
11VD														X			
Mine Pool		O	O	O	O	O		O		O	O	O		O		O	Elevation and hour meters on pumps
Surface Locations																	
West Fork		X	X	X	X												
South Fork								X				X					
Deadwood Creek														X			
Phil Sheridan Drift		X	X	X	X												
Piezometers (old + new)		X	X	X	X	O		X								X	
Upper Diversion		O	O	O	O			O		X	X	X					

Note: X - Mitigations require monitoring at this location to adequately assess performance.
O - Monitoring at this location would provide additional information that could be used to assess mitigation performance.

6.0 References

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Appendix A

Raw Data Summary Sheets

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

5BK - Becker
4x36 cutthroat flume installed on 11/6/98, 90 V-notch weir used previously; S_t = 0.66 ft, C = 1.459, n1 = 1.84

	Field Parameter								Total Metals: EPA CLP Lab Analytes																						
Sampling Date/Time	Temperature (deg C)	pH	Conductivity (umhos/cm)	Ha (ft)	Hb (ft)	S	Free Flow Q (gpm)	Comments	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)
11/06/1998 7:55	6.3	3.17	550	0.12	-	-	13.2	Flume Installation	25.1	3,840	552	29.7	1.2	11,400	161	26.7	0.9	148	326,000	0.8	865	26,300	28,000	130	28.4	5,770	41.3	1.9	16.3	2.9	70,700
12/17/1998 9:25	NM	2.31	2,100	0.15	-	-	20.0	* pH, EC measured during sample processing	38.3	7,830	1,130	15.5	4.3	25,300	961	95.6	5.0	587	715,000	0.3	798	64,000	48,700	6,730	106.0	1,700	20.0	1.9	47.5	2.9	321,000
01/14/1999 10:45	NM	2.4	950	0.15	-	-	20.0	* pH, EC measured during sample processing	2.0	6,080	608	10.3	4.5	28,600	727	91.1	12.2	421	601,000	0.2	640	66,900	69,900	1,490	97.0	679	3.0	4.0	unusable	1.0	316,000
02/05/1999 7:25	6	3.23	2,050	0.13	-	-	15.3	-	37.9	9,940	897	9.3	5.4	35,500	1,060	138.0	6.7	653	929,000	0.1	660	79,700	101,000	22,200	150.0	648	7.6	43.4	13.1	1.4	465,000
03/01/1999 7:51	5.6	2.19	1,310	0.2	-	-	33.9	Substantial increase in West Motor Drift & Ore Chute	24.8	6,830	278	9.3	3.1	28,500	541	74.4	4.1	297	420,000	0.1	822	70,100	57,300	1,860	82.4	884	3.5	28.7	22.4	1.4	234,000
03/31/1999 9:45	7	2.87	2,800	0.22	-	-	40.4	-	69.7	28,500	1,690	9.2	8.7	41,700	1,940	199.0	0.7	1,100	1,260,000	0.2	590	85,400	119,000	11,600	191.0	851	12.1	3.1	31.5	1.4	845,000
04/13/1999 9:20	6.6	3.04	2,960	0.18	-	-	27.9	-	3.0	35,100	1,380	12.2	9.6	45,000	2,420	244.0	6.6	853	1,230,000	0.1	671	96,700	116,000	947	182.0	1,310	3.0	3.0	49.4	5.0	860,000
04/29/1999 9:31	7.5	2.98	2,780	0.22	-	-	40.4	-	52.5	28,900	2,320	9.4	8.7	37,100	2,430	216.0	0.7	1,160	1,160,000	4.0	612	74,000	107,000	12,600	189.0	1,090	13.4	unusable	31.0	1.5	962,000
05/19/1999 10:25	8.2	3.02	2,300	0.18	-	-	27.9	-	44.3	24,000	1,150	9.1	7.5	35,100	1,890	194.0	3.4	487	893,000	4.4	734	73,600	105,000	26,400	167.0	1,360	16.0	3.0	5.6	1.5	812,000
05/27/1999 10:30	7.8	3.58	2,110	0.175	0.055	0.31	26.5	-	19.3	17,100	865	13.0	7.5	32,400	1,440	156.0	21.9	442	744,000	0.2	684	60,100	84,800	1,710	87.6	1,360	5.0	4.0	7.0	11.4	531,000
06/09/1999 10:50	6.9	3.50	1,960	0.14	-	-	17.6	-	8.3	14,600	710	9.5	5.9	28,600	1,180	143.0	1.9	339	663,000	0.1	721	60,100	88,400	5,070	129.0	1,420	5.3	5.6	9.7	1.5	539,000
07/27/1999 9:47	6.7	2.94	2,400	0.06	-	-	3.7	-	35.7	12,400	685	7.9	6.8	36,000	1,100	152.0	7.2	374	779,000	0.1	769	87,200	102,000	28,300	155.0	859	10.7	71.9	178.0	1.4	495,000
08/26/1999 10:08	10.1	2.64	1,730	0.08			6.3		35.9	9,190	526	8.3	5.5	32,600	907	125.0	4.9	298	606,000	0.1	749	80,100	91,400	28,800	128.0	904	8.3	61.2	143.0	1.4	442,000
Average =	7.2	2.9	2,000				22.5		30.5	15,716	983.9	11.7	6.1	32,138	1,289	142.7	5.9	550.7	794,307.7	0.8	716.5	71,092	86,036	11,372	130.2	1,449	11.5	19.3	46.2	2.7	530,208
Worst Water =	10.1	2.2	2,960				40.4		69.7	35,100	2,320	29.7	9.6	45,000	2,430	244.0	21.9	1,160	1,260,000	4.4	865.0	96,700	119,000	28,800	191.0	5,770	41.3	71.9	178.0	11.4	962,000

NOTES: unusable = The data are unusable. (Analyte may or may not be present). Reported in Data Validation Reports by EPA.

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

5BK - Becker
4x36 cutthroat flume installed on 11/6/98, 90 V-notch weir used previously; St = 0.66 ft, C = 1.459, n1 = 1.84

	Dissolved Metals, EPA CLP Lab Analytes																							QAL Lab Analytes				
Sampling Date/Time	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)	Sulfate (mg/L)	TSS (mg/L)	Lime Demand / Solids Formed (lbs/1,000 gal)		Dissolved Ferrous Iron (mg/L)
11/06/1998 7:55	3.6	1,330	4.9	14.8	0.8	11,000	124	17.9	0.9	59.8	35,400	0.1	710	23,900	15,000	130	18.8	1,010	4.0	1.9	5.8	2.9	58,900	464	249	3	2.34	< 10.0
12/17/1998 9:25	28.6	8,360	788	12.1	4.8	27,200	987	100	4.8	624	597,000	0.1	849	65,800	49,700	6,250	112	1,040	9.7	1.9	43.7	2.9	349,000	2,070	325	14.4	16.4	75
01/14/1999 10:45	2.0	6,060	555	13.2	4.4	28,100	678	86.5	8.0	410	582,000	0.2	655	65,400	63,300	1,580	92.6	618	3.0	32.8	unusable	1.0	284,000	2,290	27	16.4	14.5	101
02/05/1999 7:25	35.1	10,100	900	14.2	5.5	35,400	1,070	140	6.6	570	937,000	0.1	746	80,000	102,000	22,900	150	656	11.3	36.2	13.8	1.4	462,000	3,440	34	24.0	25.8	249
03/01/1999 7:51	21.2	7,070	276	10.6	3.2	28,600	552	76	4.3	300	425,000	0.1	871	71,100	59,100	2,140	84	840	3.5	27.6	18.8	1.4	243,000	1,770	39	11.0	10.7	109
03/31/1999 9:45	68.6	32,600	1,910	10.2	9.8	47,200	2,170	224	1.1	1,260	1,400,000	0.1	675	95,600	133,000	16,400	215	928	11.8	3.1	38.8	1.4	933,000	2,640	38	36.7	60.9	676
04/13/1999 9:20	1.1	35,800	1,390	13.1	9.7	46,200	2,470	248	3.1	875	1,220,000	0.1	637	98,700	116,000	1,060	188	1,390	3.0	3.0	48.2	6.3	870,000	4,440	27	33.4	37.1	486
04/29/1999 9:31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,370	32	36.7	49.8	-
05/19/1999 10:25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,760	44	26.7	26.8	-
05/27/1999 10:30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,100	19	23.4	23.6	-
06/09/1999 10:50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,790	22	20	21.1	134
07/27/1999 9:47	34.4	12,400	662	7.8	6.8	36,100	1,100	152	7.5	373	769,000	0.1	797	87,200	104,000	27,800	156	863	8.8	70.9	175.0	1.4	525,000	3,360	30	23.4	24.4	56
08/26/1999 10:08	34.5	9,450	539	7.5	5.5	33,300	929	129	5.2	306	610,000	0.1	769	82,300	92,200	30,100	131	926	7.2	60.3	141.0	1.4	450,000	2,740	24	20	20	11
Average =	25.5	13,686	780.5	11.5	5.6	32,567	1,120	130.4	4.6	530.9	730,600.0	0.1	745.4	74,444	81,589	12,040	127.5	919.0	6.9	26.4	60.6	2.2	463,878	2,941.1	70.0	22.2	25.6	210.8
Worst Water =	68.6	35,800	1,910	14.8	9.8	47,200	2,470	248.0	8.0	1,260	1,400,000	0.2	871.0	98,700	133,000	30,100	215.0	1,390	11.8	70.9	175.0	6.3	933,000	5,370.0	325.0	36.7	60.9	676.0

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

5WM - Williams
4x36 cutthroat flume operating as of 10/98; St = 0.66 ft, C = 1.459, n1 = 1.84

	Field Parameter								Total Metals, EPA CLP Lab Analytes																						
Sampling Date/Time	Temperature (deg C)	pH	Conductivity (umhos/cm)	Ha (ft)	Hb (ft)	S	Free Flow Q (gpm)	Comments	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)
11/06/1998 7:40	7.3	4.68	155	-	-	-		-	1.1	461	27.3	23.9	0.6	7,350	18.7	6.2	0.9	26.0	11,900	0.1	717	6,130	4,020	459	6.2	167	4.0	1.9	3.6	2.9	7,781
12/17/1998 10:24	NM	2.73	400	0.39	0.10	0.256	115.8	* pH, EC measured during sample proc.; water bit turbid due to approach hike	3.5	671	140.0	24.6	0.6	10,900	66.2	8.5	0.9	46.6	49,900	0.1	742	12,900	7,310	621	10.0	337	4.0	1.9	4.2	2.9	20,100
01/14/1999 10:53	NM	3.08	160	0.41	-	-	126.9	*pH, EC measured during sample processing	2.0	1,840	621.0	24.5	1.0	9,910	31.0	5.4	2.1	77.2	233,000	0.2	545	11,900	6,350	1,200	5.4	1,620	9.2	4.0	unusable'	1.0	9,530
02/05/1999 7:45	7.7	3.75	337	0.38	-	-	110.4	-	3.3	485	16.8	22.3	0.3	10,600	49.3	6.5	0.7	36.6	14,000	0.1	799	16,600	8,380	950	8.1	175	3.5	3.1	4.9	1.4	16,500
03/01/1999 8:04	2.8	3.99	252	0.38	-	-	110.4	prior to cleaning flume; stg=0.4	1.2	448	13.7	19.5	0.3	9,220	42.2	5.0	0.7	18.5	9,750	0.1	687	13,400	6,830	447	6.1	152	3.5	3.1	4.9	1.4	14,200
03/31/1999 10:05	7.7	3.5	500	0.47	0.11	0.234	163.2	-	4.3	1,580	49	17.2	0.3	12,100	157	12	0.7	48	35,500	0.1	698	25,300	13,800	106	14.6	266	3.5	3.1	5.1	1.4	46,000
03/31/1999 10:05	Field Duplicate (5FE)							-	4.8	1,560	49.3	17.0	0.6	12,800	157.0	12.3	1.6	45.3	35,700	0.1	708	25,200	13,800	106	14.7	269	3.5	3.1	5.7	1.4	46,300
04/13/1999 9:50	7.8	3.67	377	0.42	-	-	132.7	-	1.0	1,780	26.7	20.8	1.0	11,400	142.0	10.4	1.0	47.1	23,600	0.1	630	20,400	11,800	980	11.0	266	3.0	3.0	5.0	1.0	36,600
04/13/1999 9:50	Field Duplicate (5FE)							-	1.0	1,780	28.3	20.8	1.0	11,300	141.0	10.5	1.0	44.9	22,900	0.1	648	20,100	11,600	905	10.8	276	3.0	3.0	5.0	1.0	36,600
04/29/1999 9:49	7.9	3.53	370	0.44	-	-	144.6	-	2.6	1,540	35.6	17.6	0.2	9,040	126.0	9.8	0.7	36.7	29,800	6.0	639	13,900	8,980	104	9.6	204	2.1	unusable'	5.6	1.5	35,500
04/29/1999 9:49	Field Duplicate (5FE)							-	3.8	1,710	40.1	21.0	0.3	10,000	142.0	11.2	2.2	40.5	33,400	6.8	719	15,400	10,100	104	12.2	231	2.1	unusable'	5.6	1.5	39,700
05/19/1999 10:31	7.9	3.7	330	0.44	-	-	144.6	-	2.8	1,080	19.5	22.2	0.4	9,140	76.4	8.1	0.7	28.5	15,300	9.3	815	12,100	8,000	670	9.9	244	2.1	3.0	5.6	1.5	23,500
05/27/1999 10:45	8.8	4.2	280	0.43	0.105	0.247	135.6	-	1.2	828	18.5	21.5	1.0	8,990	60.9	5.9	1.0	30.6	13,900	0.2	519	10,700	6,950	950	6.0	219	5.0	4.0	7.0	1.5	18,100
06/09/1999 11:00	7.9	3.86	220	0.42	-	-	132.7	-	1.6	882	20.9	25.4	0.4	9,740	56.0	6.9	0.7	25.8	13,200	0.1	866	11,100	7,300	291	7.4	237	2.1	unusable'	5.6	1.5	18,700
07/27/1999 9:58	7.8	3.94	210	0.40	-	-	121.3	-	1.7	539	19.7	23.6	0.4	7,560	25.3	5.3	1.0	23.0	8,090	0.1	803	7,200	4,830	846	7.9	195	3.0	2.3	3.3	1.4	9,420
08/26/1999 10:15	7.8	4.13	152	0.41	-	-	126.9	-	1.4	388	19.3	22.4	0.4	6,780	18.1	3.7	1.0	22.7	7,900	0.1	708	6,060	4,120	890	5.0	188	3.0	2.3	3.3	1.4	6,650
Average =	7.4	3.8	287.9				130.4		2.3	1,098.3	71.6	21.5	0.5	9,801.9	81.8	8.0	1.1	37.4	34,865	1.5	702.7	14,274	8,385.6	601.8	9.1	315.4	3.5	2.9	5.0	1.5	24,074
Worst Water =	8.8	2.7	500.0				163.2		4.8	1,840.0	621.0	25.4	1.0	12,800	157.0	12.3	2.2	77.2	233,000	9.3	866.0	25,300	13,800	1,200.0	14.7	1,620.0	9.2	4.0	7.0	2.9	46,300

NOTES: *unusable = The data are unusable. (Analyte may or may not be present). Reported in Data Validation Reports by EPA.*

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

5WM - Williams
4x36 cutthroat flume operating as of 10/98; S_t = 0.66 ft, C = 1.459, n1 = 1.84

	Dissolved Metals, EPA CLP Lab Analytes																						QAL Lab Analytes				
Sampling Date/Time	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)	Sulfate (mg/L)	TSS (mg/L)	Lime Demand / Solids Formed (lbs/1,000 gal)		Dissolved Ferrous (mg/L)
11/06/1998 7:40	1.1	236	8.9	23.1	0.6	7,450	14.0	4.5	0.9	18.7	6,020	0.1	695	5,900	3,560	689	4.8	64.7	4.0	1.9	3.6	2.9	5,600	58.2	< 10.0	1.67	0.48	< 10.0
12/17/1998 10:24	2.3	599	9.5	25.7	0.6	12,000	65.9	9.2	0.9	57.4	11,600	0.1	906	13,200	7,480	1,230	10.1	241	4.0	1.9	3.6	2.9	19,900	209	95	1.00	0.72	< 10.0
01/14/1999 10:53	2.0	437	4.0	31.9	1.0	10,900	30.2	5.1	1.2	42.1	4,020	0.2	647	13,000	6,130	2,020	12.6	386	3.0	4.0	unusable'	1.0	9,870	96	< 10.0	0.67	0.33	< 10.0
02/05/1999 7:45	3.3	427	8.5	28.8	0.3	9,820	47.6	6.5	0.7	23.8	9,090	0.1	810	16,100	8,030	1,000	6.9	164	3.5	3.1	4.9	1.4	15,900	155	23	0.67	0.30	< 10.0
03/01/1999 8:04	1.7	477	10.4	27.5	0.3	10,500	47.9	5.7	0.7	23.4	6,720	0.1	800	15,200	7,710	631	7.9	162	3.5	3.1	4.9	1.4	16,000	149	20	0.67	0.58	< 10
03/31/1999 10:05	4.5	1,850	19.2	24.8	0.4	14,300	185.0	14.2	1.1	60.6	34,700	0.1	838	29,700	16,300	106	15.3	303	3.5	3.1	6.9	1.4	57,600	354	51	2.00	1.98	17
03/31/1999 10:05	3.9	1,640	18.2	22.0	0.4	12,800	164.0	13.2	1.3	59.3	30,000	0.1	752	26,400	14,400	106	13.9	266	3.5	3.1	4.9	1.4	48,600	338	51	2.00	1.84	22
04/13/1999 9:50	1.0	1,800	11.9	27.8	1.0	11,700	145.0	10.7	1.0	45.4	17,600	0.1	611	20,600	11,900	1,030	11.4	263	3.0	3.0	5.0	1.0	36,600	255	37	1.34	1.16	< 10
04/13/1999 9:50	1.0	1,820	6.4	27.8	1.0	11,800	147.0	11.1	1.0	46.6	16,000	0.1	680	21,000	12,100	1,070	11.6	267	3.0	3.0	5.0	1.0	36,200	256	34	1.34	1.24	11
04/29/1999 9:49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	297	< 10	2.34	1.73	-
04/29/1999 9:49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	302	< 10	2.34	1.53	-
05/19/1999 10:31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	198	20	1.34	0.54	-
05/27/1999 10:45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	329	21	0.67	0.28	-
06/09/1999 11:00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	129	20	0.67	0.18	< 10
07/27/1999 9:58	1.4	495	11.4	23.9	0.4	7,730	25.8	4.6	1.0	22.4	5,970	0.1	782	7,280	4,860	837	6.1	185	3.0	2.3	3.3	1.4	9,460	104	11	0.33	0.18	< 10
08/26/1999 10:15	1.4	353	10.3	23.3	0.4	7,100	18.9	3.9	1.0	23.4	5,800	0.1	739	6,330	4,280	962	5.4	177	3.0	2.3	3.3	1.4	6,930	74.4	10	0.33	0.11	< 10
Average =	2.1	921.3	10.8	26.1	0.6	10,555	81.0	8.1	1.0	38.5	13,411	0.1	750.9	15,883	8,795.5	880.1	9.6	225.3	3.4	2.8	4.5	1.6	23,878	206.5	32.8	1.2	0.8	16.7
Worst Water =	4.5	1,850.0	19.2	31.9	1.0	14,300	185.0	14.2	1.3	60.6	34,700	0.2	906.0	29,700	16,300	2,020.0	15.3	386.0	4.0	4.0	6.9	2.9	57,600	354.0	95.0	2.3	2.0	22.0

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

5WR - West Reed
2x18 cutthroat flume installed on 11/6/98, trapezoidal flume used previously; St = 0.76 ft, C = 0.974, n1 = 2.15

Sampling Date/Time	Field Parameter								Total Metals, EPA CLP Lab Analytes																						
	Temperature (deg C)	pH	Conductivity (umhos/cm)	Ha (ft)	Hb (ft)	S	Free Flow Q (gpm)	Comments	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)
11/06/1998 8:10	8.7	2.81	900	0.06	-	-	1.03	Flume Installation	9.9	1,300	2	4.5	0.9	13,200	149	35.4	0.9	52	35,200	0.1	747	29,300	39,300	130	33.9	1,490	4.0	1.9	11.9	2.9	91,200
12/17/1998 9:13	NM	2.23	3,300	0.05	-	-	0.70	* pH, EC measured during sample preserv. & packaging	93.3	36,900	4,630	11.1	21.0	74,400	4,300	445	21.0	3,000	3,340,000	0.1	378	157,000	288,000	89,500	477	417	48.3	1.9	243	2.9	1,820,000
01/14/1999 11:04	NM	2.18	3,400	0.06	-	-	1.03	* pH, EC measured during sample processing	2.0	30,800	3,330	15.7	21.2	91,900	3,480	449	90.1	2,310	3,520,000	0.2	535	175,000	349,000	1,780	463	472	3.0	4.0	unusable	1.0	1,780,000
02/05/1999 7:45	8.5	3.41	4,900	0.08	-	-	1.92	moved 5WR flume d/s to old location at 8:30; new Ha=0.1', not level	53.9	30,400	2,920	9.5	16.6	78,200	3,060	406	17.6	1,890	3,500,000	0.1	400	142,000	337,000	105,000	424	331	37.6	78.7	73.4	1.4	1,920,000
03/01/1999 7:40	7.5	2.91	2,720	0.04	-	-	0.43	flows are generally higher in greenhouse area	65.5	18,800	781	7.7	8.4	49,300	1,390	194	10.7	770	1,310,000	0.1	658	96,900	151,000	18,900	209	1,120	14.5	77.7	57	1.4	759,000
03/31/1999 9:40	8.8	2.75	4,800	0.21	-	-	15.25	-	98.5	49,500	2,960	10.0	14.9	59,800	3,250	338	0.9	1,960	2,330,000	0.2	480	106,000	211,000	36,800	322	847	26.7	3.1	50	1.4	1,530,000
04/13/1999 9:25	8.3	2.81	4,270	0.18	-	-	10.95	-	1.2	65,700	2,620	14.7	17.1	69,700	4,400	442	10.4	1,650	2,500,000	0.2	618	132,000	225,000	911	327	1,370	3.0	18.4	136	11.5	1,590,000
04/29/1999 9:20	9.4	2.74	4,260	0.22	-	-	16.86	leveled flume	87.9	40,800	3,470	8.0	12.9	47,300	3,410	309	0.7	1,730	1,810,000	3.7	394	86,400	157,000	27,200	273	803	22.7	unusable	52	1.5	1,500,000
05/19/1999 9:50	9	2.67	4,320	0.2	-	-	13.73	flume level; cleaned ditch	59.7	36,400	1,810	9.3	10.9	45,500	2,770	289	6.2	752	1,450,000	7.5	727	89,200	163,000	51,600	250	1,180	23.2	3.0	6	1.5	1,270,000
05/27/1999 10:58	9	2.74	3,490	0.175	0.055'	0.31	10.31	-	31.8	29,500	1,530	11.2	11.8	45,200	2,340	257	36.8	754	144,000	0.2	668	76,800	14,500	1,720	141	1,130	5.0	4.0	7	10.6	90,400
06/09/1999 11:20	8.1	2.7	3,100	0.14	-	-	6.38	-	0.7	27,100	1,290	8.2	10.1	41,500	2,000	248	4.3	616	1,290,000	0.1	656	76,500	155,000	21,600	221	1,340	10.0	unusable	20	1.5	1,020,000
06/09/1999 11:20	**Field Duplicate (5FE)**							-	10.3	27,600	1,330	8.3	10.5	43,600	2,080	258	5.9	626	1,310,000	0.1	694	79,200	157,000	22,900	229	1,390	15.0	4.5	24	1.5	1,040,000
07/27/1999 9:42	8.1	2.06	3,500	0.06	-	-	1.03	-	61.2	25,000	1,430	7.6	13.1	54,400	2,090	291	12.0	768	1,610,000	0.1	689	114,000	197,000	71,000	290	963	22.3	144.0	364	1.4	1,200,000
08/26/1999 10:05		2.69	3,340	0.07			1.44	pulled flume	69.9	21,000	1,230	6.6	12.2	53,400	1,940	271	10.0	687	1,520,000	0.1	628	114,000	215,000	82,500	271	1,030	20.6	140.0	331	1.4	1,080,000
Average =	8.5	2.7	3,561.5				6.2		46.1	31,486	2,095	9.5	13.0	54,814	2,619	302.3	16.3	1,255	1,833,514	0.9	590.9	105,307	189,914	37,967	280.8	991.6	18.3	40.1	105.9	3.0	1,192,186
Worst Water =	9.4	2.1	4,900.0				16.9		98.5	65,700	4,630	15.7	21.2	91,900	4,400	449.0	90.1	3,000	3,520,000	7.5	747.0	175,000	349,000	105,000	477.0	1,490	48.3	144.0	364.0	11.5	1,920,000

NOTES: unusable = The data are unusable. (Analyte may or may not be present). Reported in Data Validation Reports by EPA.
Shaded Cells = These data are suspect due to laboratory dilution procedures, but they are included in analysis.

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

5WR - West Reed
2x18 cutthroat flume installed on 11/6/98, trapezoidal flume used previously; St = 0.76 ft, C = 0.974, n1 = 2.15

Sampling Date/Time	Dissolved Metals, EPA CLP Lab Analytes																							QAL Lab Analytes				
	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)	Sulfate (mg/L)	TSS (mg/L)	Lime Demand / (lbs/1,000 gal)	Solids Formed (lbs/1,000 gal)	Dissolved Ferrous Iron (mg/L)
11/06/1998 8:10	10.3	1,340	2	39.7	1.6	13,200	143	42.6	2.4	56.8	34,300	0.1	719	28,400	37,600	130	41	1,380	5.4	1.9	11.3	3.8	88,600	523	< 10.0	4.34	4.29	<10.0
12/17/1998 9:13	90.2	37,800	4,720	12.2	20.8	74,900	4,210	439	16.3	3,020	3,410,000	0.2	515	151,000	290,000	77,600	469	414	40.7	1.9	245.0	2.9	1,820,000	11,900	95	96.8	232	620
01/14/1999 11:04	2.0	31,200	3,030	22.2	19.8	89,000	3,180	416	65.0	2,100	3,770,000	0.2	532	170,000	355,000	1,650	456	361	3.0	232.0	unusable	1.0	1,690,000	13,500	91	117	257	774
02/05/1999 7:45	51.1	33,400	3,220	15.6	18.0	83,900	3,300	442	20.2	2,050	3,980,000	0.1	437	155,000	378,000	116,000	463	350	46.1	59.3	63.1	1.4	2,070,000	12,600	77	100	232	1,050
03/01/1999 7:40	59.3	20,900	862	9.8	9.1	53,500	1,530	214	11.1	856	1,510,000	0.1	788	106,000	173,000	23,000	228	1,240	14.1	74.7	68.4	1.4	852,000	4,790	33	33	42.1	341
03/31/1999 9:40	97.8	50,700	2,990	12.4	14.9	60,300	3,260	341	0.7	2,010	2,420,000	0.1	521	107,000	220,000	36,600	317	858	21.1	3.1	65.6	1.4	1,600,000	2,670	39	73.4	161	1,300
04/13/1999 9:25	1.8	66,000	2,610	16.4	17.2	69,700	4,390	444	11.8	1,650	2,460,000	0.1	617	131,000	222,000	1,140	327	1,390	3.0	24.3	132.0	10.6	1,600,000	8,410	53	63.4	114	949
04/29/1999 9:20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9,020	47	63.4	128	-
05/19/1999 9:50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6,340	37	43.4	55.7	-
05/27/1999 10:58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,570	35	40.1	46.5	-
06/09/1999 11:20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,530	40	36.7	45.8	268
06/09/1999 11:20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,240	28	36.7	54.1	254
07/27/1999 9:42	58.0	25,700	1,440	9.1	13.3	56,500	2,150	299	13.0	789	1,750,000	0.1	639	117,000	205,000	74,500	298	967	22.9	141.0	370.0	1.4	1,210,000	6,740	35	46.7	71.3	168
08/26/1999 10:05	68.0	21,000	1,220	8.2	12.0	53,800	1,940	270	10.1	687	1,480,000	0.1	656	114,000	210,000	83,300	271	1,030	21.6	133.0	324.0	1.4	1,050,000	6,410	36	43.4	56.7	53
Average =	48.7	32,004	2,233	16.2	14.1	61,644	2,678	323.1	16.7	1,469	2,312,700	0.1	602.7	119,933	232,289	45,991	318.9	887.8	19.8	74.6	159.9	2.8	1,331,178	7,088.8	49.7	57.0	107.2	577.7
Worst Water =	97.8	66,000	4,720	39.7	20.8	89,000	4,390	444.0	65.0	3,020	3,980,000	0.2	788.0	170,000	378,000	116,000	469.0	1,390	46.1	232.0	370.0	10.6	2,070,000	13,500	95.0	117.0	257.0	1,300

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9BO - Bailey Ore Chute (Measure flow at Bailey Flume, Collect samples at Bailey Ore Chute)
4x36 cutthroat flume operating as of 10/98; St = 0.66 ft, C = 1.459, n1 = 1.84, C1 = 0.837, n2 = 1.48

	Field Parameter								Total Metals, EPA CLP Lab Analytes																						
Sampling Date/Time	Temperature (deg C)	pH	Conductivity (umhos/cm)	Ha (ft)	Hb (ft)	S	Q (gpm)	Comments	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)
11/13/1998	11.7	5.21	375	0.48	0.41	0.85	149.05	Bailey Flume	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
11/13/1998	11.2	3.55	340	-	-	-		Bailey Ore Chute	1.1	558	27.5	4.7	0.6	3,690	2.1	8.1	0.9	4.2	16,200	0.1	737	1,870	2,010	592	6.3	37.2	4.0	1.9	3.6	2.9	968
12/01/1998	11.3	4.42	92	0.46	0.42	0.91	120.08	Bailey Ore Chute	1.1	561	23.6	5.1	0.6	3,790	1.7	7.8	0.9	12.8	15,100	0.1	794	1,650	1,790	693	3.9	28.3	4.0	unusable'	3.6	2.9	550
12/16/1998	11.3	4.45	220	0.469	0.39	0.83	147.56	Bailey Ore Chute	1.4	546	27.7	5.0	0.6	3,450	1.4	7.7	0.9	4.5	15,000	0.1	722	1,560	1,750	597	5.5	27.9	4.0	1.9	3.6	2.9	400
01/07/1999 11:25	11.3	5.0	110	0.39	0.16	0.41	115.8	* pH paper used	2.0	529	28.8	5.5	1.0	4,670	1.0	6.1	1.0	25.8	15,200	0.2	440	1,630	1,450	1,060	4.5	23.7	3.0	4.0	5.1	1.0	409
02/10/1999 10:35	9.4	3.85	225	0.42	0.24	0.57	132.7	an ore chute at top of 9CR	1.2	593	24.7	5.7	0.4	3,430	0.5	7.6	1.3	237.0	14,200	0.1	724	1,390	1,590	639	5.6	46.3	3.5	3.1	4.9	1.4	592
02/26/1999 10:49	11.1	5.92	90	0.423	0.158	0.37	134.5	semi-submerged	0.7	764	32.4	5.4	0.3	3,890	7.9	9.6	0.7	35.9	19,000	0.1	744	1,870	2,170	655	6.9	29.2	3.5	3.1	4.9	1.4	3,440
04/02/1999 11:10	11.2	5.45	92	0.38	-	-	110.4	-	1.5	753	33.7	5.2	0.3	3,500	0.3	8.2	1.2	6.2	15,200	0.1	698	1,410	1,610	681	5.5	25.7	3.5	3.1	4.9	1.4	526
04/14/1999 11:00	11.2	5	91	0.41	-	-	126.9	-	2.0	824	34.9	5.4	1.0	3,460	1.0	8.5	1.1	6.0	16,800	0.2	600	1,600	1,740	664	6.3	26.1	5.0	3.0	3.0	1.0	949
05/05/1999 11:30	11.5	3.68	183	0.45	-	-	150.7	-	1.3	1,020	41.7	5.2	0.2	3,700	2.1	9.7	0.7	6.6	17,400	5.4	780	1,710	1,950	548	5.8	35.4	2.1	unusable'	5.6	1.5	1,700
05/05/1999 11:30	9BO Field Duplicate (9FE) for CLP							-	1.0	887	32.9	4.6	0.2	3,150	1.1	7.7	0.7	5.2	14,700	4.9	682	1,470	1,640	387	3.9	27.8	2.1	unusable'	5.6	1.5	550
05/21/1999 11:10	11.3	4.2	130	0.46	-	-	156.9	-	1.6	1,270	40.9	5.4	0.2	3,480	2.3	9.5	0.7	7.9	17,900	7.2	835	1,770	2,030	817	7.1	32.0	2.1	3.0	5.6	1.5	1,400
05/28/1999 11:00	11.3	4.23	170	0.46	0.31	0.67	156.9	-	1.0	1,010	38.5	5.1	1.1	3,450	1.0	8.1	1.0	18.2	19,100	0.2	480	1,590	1,870	727	4.4	26.6	5.0	4.0	7.0	1.0	528
06/04/1999 10:32	11.3	6.15	132	0.465	0.28	0.6	160.0	No samples taken, semi-submerged	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/18/1999 11:05	11.2	4.35	290	0.45	0.35	0.78	150.7	semi-submerged	0.7	1,160	40.8	5.7	0.6	4,150	7.0	11.6	0.7	12.1	21,800	0.1	823	2,180	2,500	599	8.9	39.7	2.1	unusable'	5.6	1.5	2,940
09/10/1999 10:55	11.2	3.98	161	0.46	-	-	156.9	-	1.4	665	31.5	4.7	0.4	3,820	4.3	10.1	1.0	4.2	19,800	0.1	806	1,980	2,420	735	6.1	31.4	3.0	2.3	4.7	1.4	2,350
Average =	11.2	4.6	180.1				140.6		1.3	796	32.8	5.2	0.5	3,688	2.4	8.6	0.9	27.6	16,957	1.4	704.6	1,691	1,894	671	5.8	31.2	3.4	2.9	4.8	1.7	1,236
Worst Water =	11.7	3.6	375.0				160.0		2.0	1,270	41.7	5.7	1.1	4,670	7.9	11.6	1.3	237.0	21,800	7.2	835.0	2,180	2,500	1,060	8.9	46.3	5.0	4.0	7.0	2.9	3,440

NOTES: unusable = The data are unusable. (Analyte may or may not be present). Reported in Data Validation Reports by EPA.

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9BO - Bailey Ore Chute
4x36 cutthroat flume operating as of 10/98; S_t = 0.66 ft, C = 1.459, n1 = 1.84, C1 = 0.837, n2 = 1.48

Sampling Date/Time	Dissolved Metals, EPA CLP Lab Analytes																							QAL Lab Analytes				
	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)	Sulfate (mg/L)	TSS (mg/L)	Lime Demand / Solids Formed (lbs/1,000 gal)		Dissolved Ferrous Iron (mg/L)
11/13/1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
11/13/1998	1.1	641	16.5	5.5	0.6	4,710	12.2	11.3	0.9	12.5	19,200	0.1	777	2,910	3,010	545	6.8	29.5	4.0	1.9	3.6	2.9	6,110	54.0	< 10	0.67	0.3	17
12/01/1998	1.1	491	12.0	4.6	0.6	4,080	2.7	8.4	0.9	4.8	14,600	0.1	760	1,820	2,000	756	4.9	24.6	4.0	1.9	3.6	2.9	1,670	50.1	< 10	1.00	0.18	20
12/16/1998	1.5	505	13.2	5.0	0.6	3,610	4.7	7.7	1.4	7.2	14,300	0.1	712	1,740	1,900	870	6.2	21.1	4.0	1.9	3.6	2.9	2,860	54.7	20	1.00	0.18	20
01/07/1999 11:25	2.0	456	11.2	10.2	1.0	4,060	1.2	6.5	1.0	32.5	12,200	0.2	408	1,470	1,330	1,010	5.5	20.2	3.0	4.0	6.9	1.0	374	43.8	21	0.67	0.16	11
02/10/1999 10:35	0.7	585	11.3	12.2	0.3	3,610	2.3	7.8	0.7	61.5	13,800	0.1	770	1,590	1,820	838	5.2	26.3	3.5	3.1	4.9	1.4	1,320	30.3	26	0.67	0.15	14
02/26/1999 10:49	0.7	655	10.8	15.2	0.3	3,770	1.1	8.3	1.1	29.7	13,900	0.1	797	1,580	1,750	758	6.1	26	3.5	3.1	4.9	1.4	524	51.1	22	0.67	0.04	17
04/02/1999 11:10	0.9	783	16.8	7.7	0.3	3,730	1.4	9.3	4.0	168.0	14,700	1.5	802	1,610	1,830	894	6.9	37	3.5	unusable'	4.9	1.4	1,140	52.0	26	0.67	0.37	14
04/14/1999 11:00	2.0	754	9.3	5.3	1.0	3,440	1.0	8.5	1.0	4.4	14,400	0.1	574	1,570	1,730	674	5.7	23	5.0	3.0	3.0	1.0	2,050	50.4	22	0.67	0.12	14
05/05/1999 11:30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60.8	24	0.67	0.04	-
05/05/1999 11:30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-
05/21/1999 11:10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	62.9	26	0.67	0.11	-
05/28/1999 11:00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	63.6	20	0.67	0.1	-
06/04/1999 10:32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-
06/18/1999 11:05	0.7	1,060	12.6	5.6	0.7	3,920	0.4	8.9	0.7	4.2	17,400	0.1	814	1,960	2,270	632	5.9	37	2.1	3.0	5.6	1.5	635	93.1	39	0.67	0.05	17
09/10/1999 10:55	0.4	658	10.2	5.5	0.3	3,890	0.7	9.6	0.3	2.0	18,600	0.1	842	1,930	2,320	674	5.5	27	2.2	1.8	2.0	0.8	700	80.4	15	0.67	0.24	17
Average =	1.1	659	12.4	7.7	0.6	3,882	2.8	8.6	1.2	32.7	15,310	0.3	725.6	1,818	1,996	765	5.9	27.1	3.5	2.6	4.3	1.7	1,738	57.5	23.7	0.7	0.2	16.1
Worst Water =	2.0	1,060	16.8	15.2	1.0	4,710	12.2	11.3	4.0	168.0	19,200	1.5	842.0	2,910	3,010	1,010	6.9	37.3	5.0	4.0	6.9	2.9	6,110	93.1	39.0	1.0	0.4	20.0

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9SX - Stanly Crosscut (Sampling started on 2/10/99)
4x18 cutthroat flume operating as of 10/98; St = 0.762 ft, C = 1.975, n1 = 2.15

Sampling Date/Time	Field Parameter: Temperature (deg C)	pH	Conductivity (umhos/cm)	Ha (ft)	Hb (ft)	S	Free Flow Q (gpm)	Comments	Total Metals, EPA CLP Lab Analytes: Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)
10/27/1998	Flume Installation			-	-	-		acidic water incoming through back	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
10/27/1998	-	-	-	0.12	0.10	0.83	9.29	Knocking out storage above flume, not representative	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
11/13/1998	14.8	2.12	4,380	0.04	0.03	0.75	0.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
12/01/1998	-	-	-	0.06	0.04	0.67	2.09		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
12/16/1998	14.2	2.06	4,100	0.083	0.042	0.51	4.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
01/07/1999	19.1	NM	3,850	0.06	0.01	0.17	2.09	stable for readings	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
02/10/1999 10:25	13.4	2.56	4,101	0.06	-	-	2.09	stage at 0.01 ft after cleanup	54	104,000	3,690	10.7	21.5	128,000	5,750	1,770	8.6	4,790	4,390,000	0.1	559	316,000	659,000	205,000	1,540	316	92.3	3.1	186.0	1.4	4,990,000
02/26/1999 10:16	15.3	2.72	12,800	0.095	0.045	0.47	5.62	-	45	35,400	1,660	4.4	6.7	101,000	2,260	824	5.8	2,390	929,000	0.1	795	123,000	136,000	49,100	687	529	22.9	36.7	19.5	1.4	1,010,000
04/02/1999 11:50	15.2	2.69	4,050	0.06	--	--	2.09	-	53	36,400	1,830	6.5	7.1	102,000	2,140	787	0.7	2,680	963,000	0.9	851	127,000	138,000	13,500	656	524	16.7	unusable'	66.9	1.4	920,000
04/14/1999 12:05	16	2.75	4,450	0.12	-	-	9.29	-	4.6	39,100	3,350	32.0	8.6	101,000	2,190	806	8.8	6,790	1,350,000	0.1	723	135,000	165,000	841	639	649	877.0	3.0	3.0	3.3	979,000
05/1999 12:25	18.2	2.44	4,330	0.25	-	-	45.00	-	45	29,800	2,200	4.9	6.1	111,000	1,830	591	0.7	4,510	889,000	5.8	589	109,000	106,000	6,020	492	756	21.3	unusable'	32.5	1.5	712,000
05/21/1999 11:35	17.6	2.41	5,200	0.23	-	-	37.61	replaced w/new 4x18 cutthroat flume	40	41,800	2,180	5.7	7.5	120,000	2,350	803	4.1	4,330	1,080,000	9.2	627	137,000	139,000	39,300	684	716	35.8	3.0	5.6	1.5	1,020,000
05/28/1999 11:50	19.7	0.99	5,200	0.51	-	-	267.00	flume is maxed out; made temp. weir on top of existing timber	25	33,700	2,970	5.9	7.7	106,000	2,280	755	24.7	4,700	850,000	0.2	623	91,600	107,000	1,860	604	887	5.0	4.0	7.0	20.1	721,000
06/04/1999 11:03	19.4	1.7	4,300	-	-	-	372.85	No samples taken	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/18/1999 11:30	19.1	2.01	5,200	0.27	-	-	53.09	-	10	42,600	2,030	3.9	8.5	133,000	2,940	945	1.9	4,210	956,000	0.1	578	116,000	134,000	26,500	804	594	23.9	unusable'	18.0	1.5	1,150,000
09/10/1999 11:17	16.5	2.53	3,640	0.18	0.08	0.44	22.21		38	33,000	1,390	3.5	6.5	103,000	2,250	697	5.9	2,530	787,000	0.1	772	111,000	115,000	67,400	606	725	22.0	72.1	177.0	1.4	854,000
Average =	16.8	2.2	5,046				55.7		35.0	43,978	2,367	8.6	8.9	111,667	2,666	886	6.8	4,103	1,354,889	1.8	679.7	140,622	188,778	45,502	746	632.9	124.1	20.3	57.3	3.7	1,372,889
Worst Water =	19.7	1.0	12,800				372.8		54.0	104,000	3,690	32.0	21.5	133,000	5,750	1,770	24.7	6,790	4,390,000	9.2	851.0	316,000	659,000	205,000	1,540	887.0	877.0	72.1	186.0	20.1	4,990,000

NOTES: unusable = The data are unusable. (Analyte may or may not be present). Reported in Data Validation Reports by EPA.

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9SX - Stanly Crosscut
4x18 cutthroat flume operating as of 10/98; S_t = 0.762 ft, C = 1.975, n1 = 2.15

Sampling Date/Time	Dissolved Metals, EPA CLP Lab Analytes																							QAL Lab Analytes				
	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)	Sulfate (mg/L)	TSS (mg/L)	Lime Demand / Solids Formed (lbs/1,000 gal)		Dissolved Ferrous Iron (mg/L)
10/27/1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
10/27/1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
11/13/1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
12/01/1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
12/16/1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
01/07/1999	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
02/10/1999 10:25	66.9	88,500	3,140	14.4	17.7	120,000	4,930	1,530	5.3	4,200	3,590,000	0.1	648	277,000	551,000	163,000	1,330	358	76.2	9.2	161.0	1.4	3,690,000	12,700	71	87.1	179	126
02/26/1999 10:16	50	35,700	1,680	10.6	7.0	103,000	2,310	844	6.7	2,430	960,000	0.1	842	126,000	139,000	53,100	703	539	23.5	39.1	20.1	1.4	1,000,000	4,690	29	31.4	37.5	156
04/02/1999 11:50	48	35,300	1,770	6.6	7.0	99,200	2,060	761	0.7	2,600	939,000	0.8	830	122,000	135,000	12,800	631	508	13.2	unusable'	59.3	1.4	907,000	4,920	23	33.4	42.5	229
04/14/1999 12:05	5.7	39,000	3,370	28.3	9.0	102,000	2,180	823	20.0	6,680	1,340,000	0.1	719	137,000	166,000	980	649	650	874.0	60.0	60.0	2.3	1,150,000	5,600	24	40.1	46.6	302
05/05/1999 12:25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,190	29	32.4	39.6	-
05/21/1999 11:35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,590	21	40.1	42.7	-
05/28/1999 11:50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,360	24	36.7	45.2	-
06/04/1999 11:03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-
06/18/1999 11:30	1	43,000	2,000	4.1	8.2	129,000	2,880	921	1.4	4,290	927,000	0.1	629	115,000	129,000	24,700	776	606	22.6	3.0	24.6	1.5	1,070,000	5,870	25	40.1	47.1	106
09/10/1999 11:17	25	40,900	1,790	4.6	7.1	119,000	2,700	870	9.8	3,240	883,000	0.1	954	129,000	133,000	26,700	752	753	7.3	15.7	2.0	0.8	1,100,000	5,200	24	33.4	39.1	162
Average =	32.6	47,067	2,292	11.4	9.3	112,033	2,843	958	7.3	3,907	1,439,833	0.2	770.3	151,000	208,833	46,880	807	569.0	169.5	25.4	54.5	1.5	1,486,167	6,124	30.0	41.6	57.7	180.2
Worst Water =	66.9	88,500	3,370	28.3	17.7	129,000	4,930	1,530	20.0	6,680	3,590,000	0.8	954.0	277,000	551,000	163,000	1,330	753.0	874.0	60.0	161.0	2.3	3,690,000	12,700	71.0	87.1	179.0	302.0

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

3HD - Homestake Drift
1x18 flume removed, 2x18 cutthroat flume installed on 11/20/98; St = 0.76 ft, C = 0.974, n1 = 2.15

Sampling Date/Time	Field Parameter								Total Metals, EPA CLP Lab Analytes																						
	Temperature (deg C)	pH	Conductivity (umhos/cm)	Ha (ft)	Hb (ft)	S	Free Flow Q (gpm)	Comments	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)
11/20/1998 10:20	15.7	2.68	630	0.02	-	-	0.097	-	2.6	457	100	14.5	0.6	8,320	75.1	13.2	0.9	112	35,300	0.1	1,320	4,750	5,660	681	12.5	647	4.1	1.9	3.6	2.9	19,300
11/20/1998 10:20	CLP Lab QC Duplicate							-	3.1	466	104	15.0	0.6	8,390	79.1	14.1	0.9	115	36,700	0.1	1,360	4,930	5,890	802	12.2	672	5.4	1.9	3.6	2.9	20,100
12/17/1998 11:47	NM	2.65	650	0.01	0.01	1	0.022	pH, EC measured during sample preservation & packaging; samples from pool above muck pile behind flume	4.0	868	124	15.6	0.6	8,720	152.0	15.7	8.2	318	53,400	0.1	1,340	6,370	7,100	572	16.3	950	5.8	1.9	5.8	2.9	32,900
01/14/1999 9:25	15.8	3.08	930	0.01	-	-	0.022	more water in portal drift than 12/17/98	2.0	869	172	15.0	1.0	9,180	145.0	15.1	1.8	336	68,200	0.2	915	6,140	6,680	1,230	16.4	961	3.8	4.0	4.6	1.0	33,200
01/14/1999 9:25	Field Duplicate (5FE)							-	2.0	857	178	14.7	1.0	9,470	149.0	16.2	2.2	313	68,400	0.2	849	6,360	6,700	1,390	16.7	1,190	6.2	4.0	7.9	1.0	34,800
02/05/1999 9:36	15	3.82	730	0.04	-	-	0.432	-	4.4	747	124	16.4	0.3	8,530	115.0	18.6	0.7	185	55,600	0.1	1,490	6,850	8,190	1,170	20.4	1,160	6.5	3.1	4.9	1.4	28,700
02/05/1999 9:36	Field Duplicate (5FE)							-	4.6	727	131	15.8	0.3	8,690	118.0	18.8	0.7	187	57,300	0.1	1,500	6,950	8,290	1,160	20.1	1,160	5.9	3.1	4.9	1.4	29,200
03/01/1999 9:50	15.2	3.61	500	0.01	-	-	0.022	-	3.1	505	82	15.5	0.3	8,920	68.9	15.7	0.7	85	41,000	0.1	1,440	5,860	7,100	480	16.4	1,050	5.0	3.1	4.9	1.4	21,100
03/01/1999 9:50	Field Duplicate (5FE)							-	3.3	437	83	15.6	0.3	8,650	65.5	16.6	1.0	67	40,500	0.1	1,450	5,970	7,230	498	17.2	1,040	4.7	4.5	4.9	1.4	20,600
03/31/1999 11:50	14.5	3.59	490	0.07	-	-	1.437	portal pond full to high water mark	3.3	403	31	15.4	0.3	8,230	57.2	17.0	1.0	50	34,200	0.1	1,440	6,510	8,370	216	20.3	1,480	3.5	3.1	4.9	1.4	19,100
04/13/1999 11:30	25	4.32	420	0.06	-	-	1.032	-	1.0	291	38	17.2	1.0	8,620	40.9	18.3	1.0	18.3	33,200	0.1	1,290	5,930	7,570	1,020	19.0	1,310	3.0	3.0	5.0	1.0	16,200
04/29/1999 11:29	4	3.85	400	0.075	-	-	1.667	-	2.1	187	20	14.2	0.2	6,890	29.9	13.1	1.1	14	23,600	4.9	1,350	4,730	6,080	276	14.7	1,090	2.1	unusable'	5.6	1.5	12,500
05/19/1999 9:25	14.1	3.68	400	0.07	-	-	1.437	-	3.0	158	22	16.8	0.3	7,990	23.3	15.7	0.7	11	25,300	5.2	1,570	4,930	6,500	916	16.7	1,060	2.1	3.0	5.6	1.5	12,500
05/19/1999 9:25	Field Duplicate (5FE)							-	2.2	142	23	16.6	0.2	7,680	21.4	15.0	0.7	9	24,200	9.6	1,480	4,870	6,300	871	16.9	1,040	2.1	3.0	5.6	1.5	12,000
05/27/1999 9:25	14	3.5	410	0.06	0.035	0.58	1.032	-	1.1	156	26	16.6	1.0	7,940	21.7	14.8	1.0	18	24,900	0.2	1,030	4,750	6,100	1,030	13.2	979	5.0	4.0	7.0	1.5	11,700
05/27/1999 9:25	Field Duplicate (5FE)								1.6	167	30	19.6	1.0	9,260	21.4	15.2	1.0	30	25,900	0.2	1,050	4,950	6,200	1,440	13.8	986	5.0	4.0	7.0	2.3	11,800
06/09/1999 8:35	13.8	3.22	470	0.04	-	-	0.432	-	1.4	175	43	18.0	0.3	8,060	27.8	17.1	0.7	20	25,800	0.1	1,550	5,170	6,830	492	17.4	936	2.1	unusable'	5.6	1.5	13,900
07/27/1999 8:42	14.5	3.04	570	0.01	-	-	0.022	-	2.4	246	65	18.3	0.4	8,220	35.9	16.1	1.0	37	31,200	0.1	1,500	4,960	6,370	967	17.2	784	4.1	2.6	8.8	1.4	14,900
07/27/1999 8:42	Field Duplicate (5FE)							-	3.5	217	54	17.3	0.4	8,120	31.3	15.5	1.5	32	27,100	0.1	1,510	4,800	6,130	1,030	16.3	827	3.0	2.3	9.9	1.4	13,900
08/26/1999 8:55	14.8	2.99	610	0.03	-	-	0.232	-	2.8	183	65	16.4	0.4	7,800	37.1	15.3	1.0	40	31,100	0.1	1,420	4,620	5,920	1,250	13.3	767	3.0	2.3	11.5	1.4	14,400
08/26/1999 8:55	Field Duplicate (5FE)							-	2.1	154	50	15.4	0.4	7,410	33.8	13.8	1.0	34	28,200	0.1	1,330	4,450	5,680	1,110	13.0	676	3.0	2.3	6.3	1.4	13,600
Average =	14.7	3.4	554.6				0.6		2.6	400.6	74.5	16.2	0.5	8,338	64.3	15.8	1.4	96.7	37,671	1.0	1,342	5,469	6,709	885.8	16.2	988.8	4.1	3.0	6.1	1.6	19,352
Worst Water Quality =	25.0	2.7	930.0				1.7		4.6	869.0	178.0	19.6	1.0	9,470	152.0	18.8	8.2	336.0	68,400	9.6	1,570	6,950	8,370	1,440	20.4	1,480	6.5	4.5	11.5	2.9	34,800

NOTES: unusable = The data are unusable. (Analyte may or may not be present). Reported in Data Validation Reports by EPA.

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

3HD - Homestake Drift
1x18 flume removed, 2x18 cutthroat flume installed on 11/20/98; S_t = 0.76 ft, C = 0.974, n_1 = 2.15

	Dissolved Metals, EPA CLP Lab Analytes																							QAL Lab Analytes				
Sampling Date/Time	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)	Sulfate (mg/L)	TSS (mg/L)	Lime Demand / Solids Formed (lbs/1,000 gal)		Dissolved Ferrous Iron (mg/L)
11/20/1998 10:20	2.2	370	72.1	14.9	0.6	8,800	68.0	13.8	0.9	96.2	31,000	0.1	1,340	4,850	5,720	783	10.6	620	4.0	1.9	3.6	2.9	18,300	235	< 10	1.67	1.06	< 10
11/20/1998 10:20	2.3	376	71.4	15.6	0.6	8,760	69.1	13.4	0.9	96.7	31,500	0.1	1,370	4,920	5,790	817	12.5	636	4.0	2.0	3.6	2.9	18,500	-	-		-	-
12/17/1998 11:47	3.5	870	75.2	16.3	0.6	9,100	133	15.7	0.9	292	46,900	0.1	1,570	6,510	7,330	726	16.8	1,010	4.0	1.9	4.5	2.9	29,100	332	11	2.34	1.52	< 10
01/14/1999 9:25	2.0	826	126.0	18.1	1.0	8,840	126	14.3	1.0	277	60,600	0.2	837	5,820	6,060	1,220	16.1	868	4.8	4.0	7.6	1.0	29,300	337	11	2.34	1.31	< 11
01/14/1999 9:25	2.0	832	136.0	18.7	1.0	9,070	132	15.0	1.0	293	63,100	0.2	875	5,930	6,180	1,270	16.8	889	3.2	4.0	unusable	1.0	30,400	-	-		-	-
02/05/1999 9:36	3.6	679	78.4	19.0	0.3	7,730	113	16.8	0.7	185	47,400	0.1	1,420	6,340	7,530	1,080	18.4	1,070	3.5	3.1	4.9	1.4	27,600	294	17	2.00	1.43	< 10
02/05/1999 9:36	4.4	793	80.4	22.8	0.3	8,920	132	19.2	0.7	241	54,200	0.1	1,620	7,330	8,650	1,370	41.1	1,260	3.6	3.1	4.9	1.4	32,300	235	14	2.00	1.28	< 10
03/01/1999 9:50	2.3	521	70.0	20.4	0.3	8,930	74	16.6	0.7	89	39,900	0.1	1,500	6,070	7,290	573	17.1	1,050	3.5	4.1	4.9	1.4	21,700	188	< 10	1.67	0.74	< 10
03/01/1999 9:50	2.1	468	61.6	19.2	0.3	7,970	66	15.1	0.7	64	36,300	0.1	1,380	5,610	6,750	549	16.7	981	3.5	3.1	4.9	1.4	19,800	-	-		-	-
03/31/1999 11:50	3.4	396	25.4	18.4	0.3	9,520	56	17.3	1.8	44	29,800	0.3	1,410	6,280	8,210	434	21.4	1,450	3.5	3.1	4.9	1.4	19,200	207	26	1.34	0.75	< 10
04/13/1999 11:30	1.0	272	20.5	18.2	1.0	8,330	41	18.0	1.0	27	27,200	0.1	1,340	5,760	7,460	1,100	18.8	1,260	3.0	3.0	5.0	1.0	15,300	183	18	1.34	0.84	< 10
04/29/1999 11:29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	166	15	1	0.5	-
05/19/1999 9:25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	175	26	1	0.39	-
05/19/1999 9:25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	154	26	1	0.32	-
05/27/1999 9:25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	149	21	1	0.4	-
05/27/1999 9:25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	155	21	1	0.4	-
06/09/1999 8:35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	170	20	1	0.51	< 10
07/27/1999 8:42	2.3	258	31.2	17.7	0.4	8,000	33	16.0	1.3	34	24,700	0.1	1,550	4,870	6,190	963	16.6	732	3.0	3.9	7.5	1.4	14,000	166	10	1.34	0.61	< 10
07/27/1999 8:42	1.4	195	14.3	18.0	0.4	8,220	25	15.5	1.0	21	20,700	0.1	1,520	4,990	6,340	926	16.5	759	3.0	2.3	5.8	1.4	13,000	161	19	1	0.5	< 10
08/26/1999 8:55	1.8	142	3.0	16.0	0.4	7,770	26	14.1	1.0	22	18,700	0.1	1,390	4,460	5,710	1,160	13.1	640	3.0	2.3	5.9	1.4	12,300	178	22	1	0.46	<10
08/26/1999 8:55	1.9	194	12.6	16.6	0.4	7,960	36	14.6	1.0	38	26,300	0.1	1,430	4,710	5,940	1,260	14.0	646	3.0	4.0	7.8	1.4	14,100	162	23	1	0.36	< 10
Average =	2.4	479.5	58.5	18.0	0.5	8,528	75.3	15.7	1.0	121.3	37,220	0.1	1,370	5,630	6,743	948.7	17.8	924.7	3.5	3.1	5.4	1.6	20,993	202.6	18.8	1.4	0.7	<10
Worst Water Quality =	4.4	870.0	136.0	22.8	1.0	9,520	133.0	19.2	1.8	293.0	63,100	0.3	1,620	7,330	8,650	1,370	41.1	1,450	4.8	4.1	7.8	2.9	32,300	337.0	26.0	2.3	1.5	<10

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9VR - Van Raise
4x36 cutthroat flume installed on 3/5/99; St = 0.66 ft, C = 1.459, n1 = 1.84

	Field Parameter								Total Metals, EPA CLP Lab Analytes																						
Sampling Date/Time	Temperature (deg C)	pH	Conductivity (umhos/cm)	Ha (ft)	Hb (ft)	S	Free Flow Q (gpm)	Comments	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)
02/10/1999 11:40	2.5	3.91	510	-	-	-	135	120 - 150 estimated flow	8.0	1,520	31.1	19.7	1.0	16,300	173	25.6	2.4	75.0	71,700	0.1	870	31,300	24,700	701	30.4	556	3.5	3.8	4.9	1.4	69,700
02/26/1999 11:17	8.2	3.61	730	-	-	-	-	no flow measurement	9.6	1,740	25.0	18.0	1.0	16,700	193	27.4	2.8	73.9	81,000	0.1	843	31,000	26,100	1,170	32.2	611	3.5	4.7	4.9	1.4	81,100
03/05/1999 12:00				0.43	-	-	138.6	No samples taken	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
04/02/1999 11:35	8.2	3.12	750	0.48	-	-	169.7	losing 5 gpm to uncaptured flow	14.0	7,130	158.0	15.6	2.1	21,700	533.0	53.9	0.7	249.0	190,000	0.1	822	45,100	35,200	106	52.9	703	3.5	3.1	16.5	1.4	187,000
04/14/1999 11:31	8.2	3.44	1,010	0.49	-	-	176.2	-	2.1	6,200	94.6	20.0	2.0	19,000	471.0	47.9	4.1	159.0	156,000	0.1	681	39,000	40,500	866	43.1	687	420.0	3.0	3.0	1.0	176,000
05/05/1999 11:45	11	3.82	1,310	0.49	-	-	176.2	leveled flume	11.8	5,830	173.0	15.6	1.8	16,800	519.0	48.6	0.7	190.0	154,000	3.9	753	31,700	30,000	104	45.0	622	2.1	unusable	9.5	1.5	179,000
05/21/1999 11:25	8.4	3.06	910	0.495	-	-	179.5	-	9.9	4,310	68.1	17.8	1.4	15,500	355.0	39.5	0.8	92.1	102,000	7.6	895	28,500	27,100	1,380	37.1	638	2.1	3.0	5.6	1.5	142,000
05/28/1999 11:23	8.3	3.48	890	0.48	-	-	169.7	-	5.7	2,690	40.5	19.0	2.1	15,000	242.0	27.9	4.9	87.2	79,600	0.2	653	23,200	21,000	1,420	23.1	529	5.0	4.0	7.0	7.7	87,300
06/18/1999 10:25	8.5		700	0.5	-	-	182.9	pH meter won't converge	6.0	1,990	19.9	19.9	1.3	14,400	180.0	25.4	0.7	49.7	54,700	0.1	891	24,000	22,200	104	25.4	593	2.1	unusable	5.6	1.5	76,600
[illegible]/10/1999 10:25	8.8	3.36	390	0.41	0.1	0.24	126.9	-	7.4	563	7.1	20.2	0.5	10,900	55.4	12.0	1.0	24.8	15,800	0.1	876	16,700	15,200	1,550	13.6	433	3.0	2.3	5.1	1.4	24,600
Average =	8.0	3.5	800				161.6		8.3	3,553	68.6	18.4	1.5	16,256	302.4	34.2	2.0	111.2	100,533	1.4	809.3	30,056	26,889	822.3	33.6	596.9	49.4	3.4	6.9	2.1	113,700
Worst Water =	11.0	3.1	1,310				182.9		14.0	7,130	173.0	20.2	2.1	21,700	533.0	53.9	4.9	249.0	190,000	7.6	895.0	45,100	40,500	1,550	52.9	703.0	420.0	4.7	16.5	7.7	187,000

NOTES: unusable = The data are unusable. (Analyte may or may not be present). Reported in Data Validation Reports by EPA.

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9VR - Van Raise
4x36 cutthroat flume installed on 3/5/99; St = 0.66 ft, C = 1.459, n1 = 1.84

Sampling Date/Time	Dissolved Metals, EPA CLP Lab Analytes																							QAL Lab Analytes				
	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)	Sulfate (mg/L)	TSS (mg/L)	Lime Demand / Solids Formed (lbs/1,000 gal)		Dissolved Ferrous Iron (mg/L)
02/10/1999 11:40	8.6	1,630	22.4	27.5	1.0	16,500	174	25.5	1.0	125.0	71,300	0.1	950	31,800	25,000	685	32.2	561.0	3.5	3.1	5.9	1.4	70,300	514	44	3.34	2.56	< 10
02/26/1999 11:17	9.9	1,730	18.7	22.0	1.0	16,700	193	28.4	3.3	74.1	78,700	0.1	857	31,200	26,200	1,410	32.3	612.0	3.5	6.5	4.9	1.4	80,700	544	30	3.34	2.87	< 10
03/05/1999 12:00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-
04/02/1999 11:35	15.9	7,260	144.0	18.9	2.1	21,500	543	54.3	0.7	284.0	193,000	1.3	907	46,500	36,800	106	56.5	720.0	3.5	unusable	16.4	1.4	190,000	1,150	53	7.68	7.85	< 10
04/14/1999 11:31	2.2	6,170	75.7	20.1	2.4	19,300	470	49.4	4.2	158.0	150,000	0.1	664	39,800	40,700	895	44.2	703.0	426.0	3.0	3.0	1.0	177,000	981	22	5.34	4.75	< 10
05/05/1999 11:45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,040	17	6.34	5.88	-
05/21/1999 11:25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	710	24	4.34	4.04	-
05/28/1999 11:23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	603	21	3.34	3.12	-
06/18/1999 10:25	4.8	1,920	13.8	19.4	1.3	14,300	178	24.3	0.7	48.4	50,500	0.1	827	23,200	21,600	104	25.1	572.0	2.1	3.0	5.6	1.5	70,000	427	37	2.34	1.91	< 10
09/10/1999 10:25	2.1	601	5.6	20.4	0.4	11,000	56	12.2	0.4	25.2	15,200	0.1	852	16,900	15,300	412	13.2	440.0	2.2	1.8	2.0	0.8	23,700	257	16	0.67	0.89	< 10
Average =	7.3	3,219	46.7	21.4	1.4	16,550	269.0	32.4	1.7	119.1	93,117	0.3	842.8	31,567	27,600	602.0	33.9	601.3	73.5	3.5	6.3	1.3	101,950	691.8	29.3	4.1	3.8	< 10
Worst Water =	15.9	7,260	144.0	27.5	2.4	21,500	543.0	54.3	4.2	284.0	193,000	1.3	950.0	46,500	40,700	1,410	56.5	720.0	426.0	6.5	16.4	1.5	190,000	1,150	53.0	7.7	7.9	< 10

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9CR - Cherry Raise
2x18 cutthroat flume installed on 10/27/98, 30 V-notch weir used previously; S_t = 0.76 ft, C = 0.974, n1 = 2.15

	Field Parameter								Total Metals, EPA CLP Lab Analytes																						
Sampling Date/Time	Temperature (deg C)	pH	Conductivity (umhos/cm)	H_a (ft)	H_b (ft)	S	Free Flow Q (gpm)	Comments	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)
10/27/1998	Flume Installation			-	-	-		acidic water incoming through back	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
11/13/1998	13.7	2.11	4,080	0.06	-	-	1.03	-	44.1	16,100	287	9.4	7.3	52,200	1,650	331	18.3	946	1,130,000	0.1	909	121,000	176,000	16,500	300	1,030	14.1	1.9	72.9	2.9	1,030,000
12/01/1998	13.8	2.1	3,380	0.06	0.04	0.67	1.03	-	67.6	19,500	350	8.0	8.2	55,200	1,820	395	28.1	1,090	1,170,000	0.1	974	130,000	180,000	76,600	346	1,090	22.5	1.9	59.4	2.9	1,030,000
12/16/1998 11:08	13.8	2.02	5,000	0.075	0.03	0.40	1.67	-	137.0	28,000	798	10.4	11.0	64,200	2,530	437	10.8	1,990	2,130,000	0.1	734	141,000	224,000	55,600	416	900	32.5	10.5	170.0	2.9	1,290,000
01/07/1999 11:20	11.8	3.3*	4,360	0.08	0.03	0.38	1.92	* pH paper used	2.0	25,400	834	12.4	11.2	66,500	2,610	377	35.7	2,100	2,460,000	0.2	829	132,000	208,000	1,390	377	762	3.0	4.0	unusable	1.0	1,360,000
02/10/1999 10:30	11	2.59	4,000	0.10	-	-	3.09	Ha=0.11' @ 11 am	50.8	21,000	810	9.1	8.0	48,100	2,060	326	3.7	1,770	1,490,000	0.1	861	95,500	147,000	40,000	306	783	25.6	17.7	44.8	1.4	898,000
02/26/1999 10:47	12.9	2.8	5,200	0.14	0.04	0.29	6.38		77.1	66,200	1,900	9.8	15.3	75,500	3,740	887	14.7	4,350	3,010,000	0.1	770	209,000	358,000	126,000	712	587	63.6	72.2	78.6	1.4	2,340,000
04/02/1999 11:15	13.6	2.71	4,300	0.18	-	-	10.95	had to trench to collect water and get it going through flume	85.7	61,800	1,850	11.6	14.4	73,900	3,270	763	0.7	3,750	2,680,000	0.3	657	193,000	362,000	50,000	605	946	35.2	3.1	138.0	1.4	1,930,000
04/14/1999 11:52	13.8	2.67	4,500	0.27	-	-	26.18	-	50.0	93,500	3,080	76.2	25.0	91,200	5,950	1,370	25.0	5,740	3,470,000	0.2	749	266,000	438,000	771	1,020	2,840	5,990	75.0	75.0	8.5	3,050,000
05/05/1999 11:12	14.5	2.35	6,400	0.23	-	-	18.55	losing ~0.7 gpm thru back	93.9	75,900	2,450	11.3	16.8	74,700	4,040	1,030	0.7	4,690	2,840,000	6.5	639	199,000	340,000	57,300	779	752	40.9	unusable	136.0	1.5	2,500,000
05/21/1999 11:05	14.6	2.47	7,500	0.23	-	-	18.55	lower flume level; stg 0.23'	49.6	101,000	2,880	11.3	18.8	83,400	4,400	1,250	6.3	5,570	3,680,000	5.4	673	249,000	498,000	140,000	970	399	70.5	3.0	19.6	1.5	3,180,000
05/28/1999 10:45	15.7	2.22	8,100	0.43	-	-	71.21	-	52.8	81,900	6,630	12.7	15.3	55,700	3,800	1,220	56.3	7,160	2,520,000	0.2	838	119,000	257,000	1,780	682	492	5.0	4.0	7.0	30.8	1,600,000
06/04/1999 10:25	14.8	2.46	4,250	0.345	0.09	0.26	56.35	No samples taken	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/18/1999 10:55	14.5	3.81	8,100	0.27	-	-	30.18	-	0.7	80,900	2,980	7.5	13.7	57,000	3,490	1,110	12.3	6,210	2,070,000	0.1	751	142,000	301,000	52,100	789	936	49.0	unusable	52.1	1.5	1,930,000
09/10/1999 10:50	13.4	2.46	4,500	0.2	-	-	14.73	-	59.1	40,700	1,120	5.3	9.1	45,300	2,040	611	11.7	2,560	1,190,000	0.1	742	134,000	212,000	84,200	458	705	30.4	112.0	267.0	1.4	1,070,000
Average =	13.7	2.5	5,262				18.7		59.3	54,761.5	1,998	15.0	13.4	64,838	3,185	*777.5*	*17.3*	*3,687*	*2,295,385*	*1.0*	*778.9*	*163,885*	*284,692*	*54,018.5*	*596.9*	*940.2*	*490.9*	*27.8*	93.4	4.5	1,785,231
Worst Water =	15.7	2.0	8,100				71.2		137.0	101,000	6,630	76.2	25.0	91,200	5,950	1,370	56.3	7,160	3,680,000	6.5	974.0	266,000	498,000	140,000	1,020	2,840	5,990.0	112.0	267.0	30.8	3,180,000

NOTES: unusable = The data are unusable. (Analyte may or may not be present). Reported in Data Validation Reports by EPA.

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9CR - Cherry Raise
2x18 cutthroat flume installed on 10/27/98, 30 V-notch weir used previously; St = 0.76 ft, C = 0.974, n1 = 2.15

Sampling Date/Time	Dissolved Metals, EPA CLP Lab Analytes																							QAL Lab Analytes				
	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)	Sulfate (mg/L)	TSS (mg/L)	Lime Demand / Solids Formed (lbs/1,000 gal)		Dissolved Ferrous Iron (mg/L)
10/27/1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
11/13/1998	41.3	16,400	294	9.2	7.7	54,200	1,680	342	18.7	960	1,180,000	0.1	897	122,000	183,000	18.100	305	1,020	9.4	1.9	71.3	2.9	1,060,000	5,240	< 10	43.9	52.8	< 10
12/01/1998	63.6	18,900	330	8.5	7.7	53,700	1,760	380	26.3	1,060	1,100,000	0.1	936	127,000	170,000	71,500	331	1,040	20.9	unusable'	60.0	2.9	955,000	4,660	11	40.1	49.5	< 10
12/16/1998 11:08	82.2	27,100	786	10.5	10.7	62,100	2,480	428	10.5	1,940	2,100,000	0.1	778	139,000	220,000	55,500	409	808	28.7	1.9	155.0	2.9	1,270,000	7,400	34	66.8	116.0	< 10
01/07/1999 11:20	22.8	22,400	824	14.0	11.5	59,400	2,480	341	23.8	1,860	2,060,000	0.2	776	120,000	167,000	1,500	320	674	3.0	13.3	unusable'	1.0	1,190,000	7,960	57	64.4	104.0	< 10
02/10/1999 10:30	51.5	21,200	820	9.8	8.3	49,500	2,130	333	3.7	1,720	1,520,000	0.1	862	97,800	149,000	43,300	317	798	26.2	21.7	46.9	1.4	913,000	5,210	21	46.7	67.6	< 10
02/26/1999 10:47	70.2	63,000	1,790	14.7	14.3	71,500	3,520	832	13.3	4,110	2,700,000	0.1	802	198,000	326,000	114,000	668	557	56.2	72.7	82.8	1.4	2,100,000	10,700	46	73.4	186.0	22
04/02/1999 11:15	104.0	63,800	1,950	13.1	15.2	74,600	3,370	787	0.7	4,240	2,760,000	1.3	721	198,000	334,000	47,100	643	910	41.1	unusable'	153.0	1.4	2,100,000	2,510	124	86.8	197.0	42
04/14/1999 11:52	12.7	92,700	2,730	65.8	20.8	91,900	4,490	1,130	45.9	5,520	3,570,000	0.1	683	271,000	460,000	876	815	1,090	697.0	60.5	3.0	3.5	2,680,000	14,500	74	107.0	239.0	28
05/05/1999 11:12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13,900	83	93.5	220.0	-
05/21/1999 11:05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17,400	69	113.0	272.0	-
05/28/1999 10:45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10,900	56	83.4	183.0	-
06/04/1999 10:25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-
06/18/1999 10:55	0.7	118,000	4,370	9.1	18.7	74,600	4,630	1,540	11.2	9,390	3,010,000	0.1	620	178,000	420,000	71,600	1,070	557	61.6	3.0	86.7	1.5	2,660,000	17,000	69	96.8	216.0	< 10
09/10/1999 10:50	4.5	67,700	1,970	7.2	11.8	60,400	3,000	1,010	20.3	4,540	2,020,000	0.1	792	185,000	344,000	43,300	738	550	23.6	27.5	2.0	0.8	1,680,000	5,970	29	36.7	45.7	< 10
Average =	45.4	51,120	1,586	16.2	12.7	65,190	2,954	712.3	17.4	3,534	2,202,000	0.2	786.7	163,580	277,300	46,678	561.6	800.4	96.8	25.3	73.4	2.0	1,660,800	9,488	56.1	73.3	149.9	30.7
Worst Water =	104.0	118,000	4,370	65.8	20.8	91,900	4,630	1,540	45.9	9,390	3,570,000	1.3	936.0	271,000	460,000	114,000	1,070	1,090	697.0	72.7	155.0	3.5	2,680,000	17,400	124.0	113.0	272.0	42.0

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9SO - Stanly Ore Chute
Bucket and stop watch will be used for flow measurement starting in 10/98

	Field Parameter					Total Metals, EPA CLP Lab Analytes																						
Sampling Date/Time	Temperature (deg C)	pH	Conductivity (umhos/cm)	Q (gpm)	Comments	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)
11/13/1998	17.4	1.65	20,400	0.994	Volumetric	1.1	197,000	7,620	17.5	33.1	129,000	9,520	2,890	7.4	11,300	13,800,000	0.1	300	302,000	29,600	243,000	2,230	207	155	1.9	149	2.9	19,500,000
12/01/1998	14.2	2.33	18,000	0.973	Volumetric	1.1	225,000	8,470	13.8	36.0	138,000	10,400	3,450	41.3	12,100	14,000,000	0.1	162	344,000	2,200,000	691,000	2,610	146	226	1.9	117	2.9	20,000,000
12/16/1998 11:49	17.1	1.60	>50,000	1.208	Volumetric	1.1	218,000	7,640	18.3	37.1	147,000	10,100	3,220	15.8	11,200	13,200,000	0.1	150	418,000	35,000	774,000	2,550	120	196	1.9	407	2.9	19,000,000
01/07/1999 10:50	12	2.1*	22,500	1.259	Volumetric *pH paper	2.0	298,000	9,860	32.4	54.6	240,000	13,000	3,980	258.0	13,800	13,400,000	0.2	602	1,640,000	1,810,000	1,030	3,490	4.4	3.0	65.7	unusable	1.0	15,700,000
02/10/1999 10:15	16	2.07	23,800	1.475	Volumetric	0.7	170,000	5,500	15.2	31.7	136,000	7,460	2,320	15.1	8,150	12,300,000	0.1	130	374,000	30,700	320,000	1,950	112	150	3.1	201	1.4	16,600,000
02/26/1999 10:15	18	2.26	18,200	1.565	Volumetric	0.7	167,000	5,590	13.5	32.7	134,000	8,090	2,290	27.5	8,050	13,300,000	0.1	121	360,000	30,000	383,000	1,930	100	161	3.1	71	1.4	1,740,000
04/02/1999 11:45	19.2	2.23	19,000	2.831	~1 Liter/5.6 sec	0.7	168,000	7,470	19.9	33.3	143,000	7,520	2,140	0.7	7,670	10,700,000	0.2	175	398,000	35,300	181,000	1,860	139	122	3.1	275	1.4	11,100,000
04/14/1999 12:10	18.5	2.41	18,000	2.642	~1 Liter/ 6 sec	33.9	315,000	13,700	154.0	60.0	256,000	29,000	7,810	169.0	14,700	13,000,000	0.1	495	1,440,000	1,860,000	517	6,870	202	345	300.0	325	70.5	15,400,000
05/05/1999 12:20	19.8	2.3	17,000	6.923	3 gal/26 sec	0.7	153,000	9,960	17.1	29.5	150,000	7,980	2,410	0.7	8,440	8,220,000	4.2	135	341,000	1,140,000	160,000	2,010	136	118	unusable	207	1.5	9,810,000
05/21/1999 11:35	19.7	2.09	19,100	4.091	3 gal/44 sec	0.7	225,000	12,000	18.3	35.3	167,000	9,720	3,060	14.1	11,400	11,800,000	3.0	173	408,000	1,630,000	374,000	2,490	147	191	3.0	6	1.5	13,400,000
05/28/1999 12:00	19.7	0.59	14,900	30.00	3 gal/6 sec	138.0	213,000	22,800	19.2	32.4	144,000	11,100	3,610	94.7	17,000	6,610,000	0.5	354	223,000	46,500	2,810	2,340	134	5	4.0	7	108.0	6,010,000
06/04/1999 11:00	21	1.9	15,000	12.95	No samples taken	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/18/1999 11:40	21.1	2.24	18,200	6.43	3 gal/28 sec	0.7	217,000	12,600	12.7	28.5	149,000	9,120	2,910	17.4	14,700	8,260,000	0.1	164	216,000	34,700	238,000	2,140	221	127	unusable	6	1.5	11,400,000
09/10/1999 11:15	17.6	2.27	19,800	1.51	3 gal/119 sec	1.4	189,000	8,600	15.7	35.2	134,000	9,470	2,760	33.0	10,700	11,500,000	0.1	146	382,000	30,300	701,000	2,180	679	166	44.3	799	1.4	16,800,000
Average =	18.0	2.0	18,762	5.3		14.1	211,923	10,139	28.3	36.9	159,000	10,960	3,296	53.4	11,478	11,545,385	0.7	239.0	526,615.4	685,546.2	313,027	2,665	180.6	151.2	39.3	214.1	15.3	13,573,846
Worst Water =	21.1	0.6	23,800	30.0		138.0	315,000	22,800	154.0	60.0	256,000	29,000	7,810	258.0	17,000	14,000,000	4.2	602.0	1,640,000	2,200,000	774,000	6,870	679.0	345.0	300.0	799.0	108.0	20,000,000

NOTES: unusable = The data are unusable. (Analyte may or may not be present). Reported in Data Validation Reports by EPA.
Shaded Cells These data are suspect due to laboratory dilution procedures, but they are included in analysis.

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9SO - Stanly Ore Chute
Bucket and stop watch will be used for flow measurement starting in 10/98

Sampling Date/Time	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)	Sulfate (mg/L)	TSS (mg/L)	Lime Demand / Solids Formed (lbs/1,000 gal)		Dissolved Ferrous Iron (mg/L)
	Dissolved Metals, EPA CLP Lab Analytes																							QAL Lab Analytes				
11/13/1998	1.1	196,000	7,470	17.5	33.2	130,000	9,410	2,910	9.7	11,400	14,100,000	0.1	152	291,000	29,100	252,000	2,210	204	153	1.9	128	2.9	19,800,000	71,800	41	624	1,470	335
12/01/1998	1.1	223,000	8,480	14.0	36.5	140,000	10,600	3,530	41.7	12,000	13,500,000	0.1	151	358,000	2,130,000	668,000	2,680	137	232	unusable	127	2.9	19,600,000	78,700	129	601	1,550	360
12/16/1998 11:49	1.1	218,000	7,720	18.5	37.3	146,000	10,200	3,270	16.1	11,500	13,300,000	0.1	147	424,000	35,300	825,000	2,600	141	199	1.9	392	2.9	18,600,000	65,300	284	574	1,690	145
01/07/1999 10:50	119	284,000	9,990	34.1	56.4	222,000	12,800	3,760	208.0	13,100	12,400,000	0.2	662	1,510,000	1,780,000	1,130	3,060	1.0	3.0	170.0	unusable	1.0	14,300,000	62,800	331	541	1,620	101
02/10/1999 10:15	0.7	174,000	5,680	16.8	32.4	138,000	7,680	2,390	18.5	8,460	13,200,000	0.1	155	377,000	29,600	344,000	2,010	124	159	3.1	173	1.4	19,100,000	69,000	272	494	1,400	272
02/26/1999 10:15	1	171,000	5,640	17.8	32.7	136,000	8,080	2,280	26.6	8,320	13,400,000	0.1	142	362,000	29,500	372,000	1,920	108	159	3.1	65	1.4	1,760,000	68,100	164	471	1,340	517
04/02/1999 11:45	1	170,000	7,720	22.6	33.0	136,000	7,250	2,140	0.7	8,560	12,800,000	0.9	189	374,000	30,800	166,000	1,850	179	113	unusable	249	1.4	14,500,000	61,800	259	501	1,230	522
04/14/1999 12:10	38	302,000	13,300	126.0	59.3	252,000	26,000	4,140	173.0	13,900	12,900,000	0.1	474	1,370,000	2,030,000	936	3,460	177	318	237.0	3	43.5	3,760,000	57,100	207	467	1,070	413
05/05/1999 12:20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39,100	230	320	796	-
05/21/1999 11:35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45,400	272	421	1,050	-
05/28/1999 12:00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32,300	144	240	599	-
06/04/1999 11:00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-
06/18/1999 11:40	0.7	228,000	13,000	15.1	29.5	156,000	9,350	2,990	15.3	15,700	9,040,000	0.1	169	215,000	32,700	232,000	2,180	320	127	3.0	5.6	1.5	13,500,000	39,700	155	344	856	61
09/10/1999 11:15	0.4	211,000	9,910	17.6	26.6	124,000	9,480	3,060	46.4	13,200	14,500,000	0.1	100	293,000	23,100	213,000	2,550	334	112	1.8	2	0.8	18,900,000	71,100	314	527	1,320	95
Average =	16.4	217,700	8,891	30.0	37.7	158,000	11,085	3,047	55.6	11,614	12,914,000	0.2	234.1	557,400	615,010	307,407	2,452	172.5	157.5	52.7	127.1	6.0	14,382,000	58,631	215.5	471.2	1,230	282.1
Worst Water =	119.0	302,000	13,300	126.0	59.3	252,000	26,000	4,140	208.0	15,700	14,500,000	0.9	662.0	1,510,000	2,130,000	825,000	3,460	334.0	318.0	237.0	392.0	43.5	19,800,000	78,700	331.0	624.0	1,690	522.0

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9S2 - Stanly Ore Chute II

	Field Parameter					Total Metals, EPA CLP Lab Analytes																						
Sampling Date/Time	Temperature (deg C)	pH	Conductivity (umhos/cm)	Q (gpm)	Comments	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)
05/28/1999 12:45	19.2	2.49	3,510		9S2 is flowing much higher than on 5/21/99. Cross cut upstream of 9S2 has not increased in discharge	21.7	26,600	1,820	6.0	6.6	37,100	1,510	576	23.8	3,890	793,000	0.2	510	58,500	104,000	1,580	392	498	5.0	4.0	7.0	19.6	459,000
06/04/1999	20.7	2.3	3,900		pool area EC=4,400 No Samples collected	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/18/1999 12:20	No field measurements taken					7	38,700	1,980	3	7	42,500	1,720	626	4.0	4,290	873,000	0.1	155	71,000	126,000	8,720	469	336	16	unusable	12.6	1.5	629,000
09/19/1999 12:20	17.5	2.33	7,400	1.0	No samples collected	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Average =	19.1	2.4	4,937	1.0		14.4	32,650	1,900	4.3	6.8	39,800	1,615	601.0	13.9	4,090	833,000	0.2	332.5	64,750	115,000	5,150	430.5	417.0	10.4	4.0	9.8	10.6	544,000
Worst Water =	20.7	2.3	7,400	1.0		21.7	38,700	1,980	6.0	7.0	42,500	1,720	626.0	23.8	4,290	873,000	0.2	510.0	71,000	126,000	8,720	469.0	498.0	15.8	4.0	12.6	19.6	629,000

NOTES: unusable = The data are unusable. (Analyte may or may not be present). Reported in Data Validation Reports by EPA.

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9S2 - Stanly Ore Chute II

Sampling Date/Time	Dissolved Metals; EPA CLP Lab Analytes																							QAL Lab Analytes				
	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)	Sulfate (mg/L)	TSS (mg/L)	Lime Demand / Solids Formed (lbs/1,000 gal)		Dissolved Ferrous Iron (mg/L)
05/28/1999 12:45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/04/1999	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/18/1999 12:20	6.7	38,100	1,950	2.8	7.5	43,600	1,720	630	2.3	4,200	856,000	0.1	192	70,800	110,000	6,300	469	341	14.6	3.0	19.3	1.5	603,000	4,030	15	30.0	31.1	<10
09/19/1999 12:20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Average =	6.7	38,100	1,950	2.8	7.5	43,600	1,720	630.0	2.3	4,200	856,000	0.1	192.0	70,800	110,000	6,300	469.0	341.0	14.6	3.0	19.3	1.5	603,000	4,030	15.0	30.0	31.1	< 10
Worst Water =	6.7	38,100	1,950	2.8	7.5	43,600	1,720	630.0	2.3	4,200	856,000	0.1	192.0	70,800	110,000	6,300	469.0	341.0	14.6	3.0	19.3	1.5	603,000	4,030	15.0	30.0	31.1	< 10

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9LA - Loadout Area @ 9 Level
8x36 cutthroat flume installed on 12/1/98, 4x36 cutthroat flume installed on 10/16/98, 12" trapezoidal weir used previously; (St = 0.66 ft, C = 1.459, n1 = 1.84 for 4x36, C1 = 0.837, n2 = 1.48); (St = 0.66 ft, C = 2.97, n1 = 1.84 for 8x36)

	Field Parameter								Total Metals, EPA CLP Lab Analytes																						
Sampling Date/Time	Temperature (deg C)	pH	Conductivity (umhos/cm)	Ha (ft)	Hb (ft)	S	Free Flow Q (gpm)	Comments	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)
10/16/1998	-	-	-	0.82	1.63	1.99	454.5	4x36 flume inst.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
10/27/1998	-	-	-	0.69	-	-	330.8	max Ha=0.89	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
11/13/1998	10.8	2.5	1,480	0.68	0.19	0.28	322.1	-	14.4	6,010	175	11.2	2.2	28,800	390	130	0.9	325	191,000	0.1	1,020	51,500	39,200	130	113	266	4.0	1.9	14.1	2.9	203,000
12/01/1998	10.3	2.96	1,280	0.50	-	-	372.3	8x36 flume inst.	18.8	5,630	158	11.3	2.4	29,800	409	131	3.2	290	188,000	0.1	1,070	51,400	45,100	8,660	111	384	4.2	unusable'	4.0	2.9	187,840
12/01/1998	9LA Field Duplicate (9FE) for QAL Lab								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
12/16/1998 10:33	10.3	2.81	1,130	0.48	0.15	0.30	345.4	-	15.3	5,860	151	11.3	2.5	29,500	402	123	1.3	308	203,000	0.1	1,030	53,200	40,800	1,850	109	360	6.0	3.5	22.9	2.9	204,000
01/07/1999 9:58	10.3	3.3*	1,320	0.48	0.16	0.33	345.4	* pH paper used	2.0	5,510	160	10.7	2.4	28,400	373	109	5.0	324	220,000	0.2	834	50,600	38,300	1,460	101	275	3.0	5.8	unusable'	1.0	201,000
02/10/1999 9:27	8.9	3.02	1,580	0.48	-	-	345.4	flume cleaned	20.2	7,460	207	13.1	3.0	36,400	504	146	2.8	510	270,000	0.1	1,150	73,800	61,900	4,410	135	355	6.6	9.5	17.8	1.4	244,000
02/26/1999 9:45	10.4	3.22	1,460	0.5	0.152	0.30	372.3	-	24.5	7,890	227	11.6	3.1	35,800	559	152	4.2	404	288,000	0.1	1,060	71,400	66,200	8,180	137	372	4.8	18.7	9.6	1.4	265,000
03/05/1999				0.52	-	-	400.2	No samples taken	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
04/02/1999 10:05	10.3	3.01	1,800	0.58	-	-	489.2	-	28.4	12,400	389	11.4	3.8	45,900	778	179	0.7	575	387,000	0.1	1,110	100,000	85,800	106	158	498	3.5	3.4	30.8	1.4	369,000
04/14/1999 10:20	10.5	3.09	1,800	0.56	-	-	458.6	-	3.6	13,500	463	22.5	4.2	42,700	812	199	6.1	781	435,000	0.1	897	91,700	84,400	972	167	473	745.0	3.0	3.0	1.7	456,000
05/05/1999 10:45	11.8	2.92	2,510	0.63	-	-	569.6	flume broken	33.8	16,500	764	9.8	4.4	47,500	1,060	276	0.7	1,220	483,000	4.7	884	84,800	88,200	104	232	440	5.2	unusable'	32.3	1.5	468,000
05/21/1999 10:30	10.9	3.02	2,180	0.59	-	-	504.9	flume is level	30.1	16,700	638	11.9	4.5	46,500	993	278	1.4	947	466,000	7.6	1,160	88,600	90,800	13,300	240	425	10.5	3.0	5.6	1.5	506,000
05/21/1999 10:30	9LA Field Duplicate (9FE) for CLP Lab							-	25.8	15,900	592	11.2	4.0	43,300	926	260	0.7	892	432,000	3.7	1,090	83,400	85,200	11,200	223	395	8.3	3.0	5.6	1.5	478,000
05/28/1999 10:05	15.4	2.53	5,300	0.94	-	-	1,189.5	water bypassing flume	37.4	61,100	5,660	11.8	11.5	80,100	3,110	1,100	39.0	6,200	1,690,000	0.2	830	113,000	174,000	1,970	707	453	5.0	4.0	7.0	24.6	1,090,000
06/04/1999 10:00	14.6	2.57	3,700	0.815	0.305	0.37	914.8	No Samples taken	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/18/1999 9:55	12.2		2,620	0.64	-	-	586.4	pH meter won't converge	9.4	27,600	1,200	11.2	5.8	60,000	1,600	505	1.3	2,160	665,000	0.1	1,080	95,000	115,000	11,700	406	406	15.5	unusable'	11.8	1.5	738,000
06/18/1999 9:55	9LA Field Duplicate (9FE) for CLP Lab							-	11.7	25,800	1,140	10.1	5.8	58,800	1,550	490	0.7	2,000	651,000	0.1	985	91,000	111,000	9,920	391	376	13.2	5.7	11.7	1.5	726,000
07/02/1999 10:39	12.4	2.77	2,290	0.59	-	-	504.9	-	29.9	17,900	710	10.4	4.6	50,600	1,110	351	2.3	1,230	459,000	0.1	948	82,300	83,100	15,100	288	394	7.9	44.1	39.7	1.4	465,000
09/10/1999 9:45	11	2.88	1,560	0.51	-	-	386.1	-	20.0	9,580	322	10.7	3.1	35,500	585	190	2.4	569	280,000	0.1	1,060	64,800	63,600	16,900	163	373	3.7	29.6	67.4	1.4	292,000
Average =	11.3	2.9	2,134				494		20.3	15,959	810	11.9	4.2	43,725	948	289	4.5	1,171	456,750	1.1	1,013	77,906	79,538	6,623	230.1	390.3	52.9	10.4	18.9	3.2	430,803
Worst Water =	15.4	2.5	5,300				1,190		37.4	61,100	5,660	22.5	11.5	80,100	3,110	1,100	39.0	6,200	1,690,000	7.6	1,160	113,000	174,000	16,900	707.0	498.0	745.0	44.1	67.4	24.6	1,090,000

NOTES: unusable = The data are unusable. (Analyte may or may not be present). Reported in Data Validation Reports by EPA.

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9LA - Loadout Area @ 9 Level
8x36 cutthroat flume installed on 12/1/98, 4x36 cutthroat flume on 10/16/98, 12" trapezoidal weir used previously; (St = 0.66 ft, C = 1.459, n1 = 1.84 for 4x36, C1 = 0.837, n2 = 1.48); (St = 0.66 ft, C = 2.97, n1 = 1.84 for 8x36)

Sampling Date/Time	Dissolved Metals, EPA CLP Lab Analytes																							QAL Lab Analytes				
	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)	Sulfate (mg/L)	TSS (mg/L)	Lime Demand / Solids Formed (lbs/1,000 gal)		Dissolved Ferrous Iron (mg/L)
10/16/1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
10/27/1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
11/13/1998	15.8	6,080	120.0	13.0	2.4	30,300	392	133	0.9	328	184,000	0.1	1,060	52,400	40,200	130	113	268	4.0	1.9	13.7	2.9	211,000	1,150	58	5.01	6.72	50
12/01/1998	18.0	5,750	97.4	12.0	2.3	29,500	412	128	2.3	294	167,000	0.1	1,090	51,500	44,800	8,650	108	355	4.0	1.9	3.6	2.9	187,000	1,130	59	6.34	7.08	45
12/01/1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,120	70	6.68	6.84	53
12/16/1998 10:33	17.1	5,850	98.6	12.5	2.6	30,300	413	126	0.9	318	196,000	0.1	1,070	54,900	41,400	3,070	112	371	4.0	1.9	19.3	2.9	211,000	1,150	68	7.01	7.35	45
01/07/1999 9:58	2.0	5,360	120.0	19.2	2.6	27,900	389	112	3.8	308	207,000	0.2	887	50,000	39,300	1,740	95.7	272	3.0	5.4	unusable'	1.0	199,000	1,280	37	8.01	8.67	17
02/10/1999 9:27	18.9	7,410	157.0	21.2	3.1	36,200	510	148	1.1	408	256,000	0.1	1,180	74,300	66,300	4,880	134	343	3.5	8.2	15.6	1.4	264,000	1,490	95	9.01	8.97	< 10
02/26/1999 9:45	22.6	7,980	167.0	19.7	3.0	35,400	542	147	3.5	409	271,000	0.1	1,130	70,800	66,700	7,170	133	358	3.5	14.3	8.4	1.4	273,000	1,580	50	10.0	9.55	36
03/05/1999	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-
04/02/1999 10:05	30.9	12,300	321.0	15.7	3.9	44,800	782	178	0.7	587	378,000	1.6	1,190	100,000	84,300	106	166	496	4.0	unusable'	38.4	1.4	347,000	2,260	151	13.7	15.7	28
04/14/1999 10:20	3.6	12,900	410.0	20.1	4.2	41,100	774	194	5.7	743	410,000	0.1	824	89,400	16,100	902	161	452	731.0	3.0	3.0	1.0	437,000	2,240	38	14	13.6	34
05/05/1999 10:45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,000	33	23.4	22.8	-
05/21/1999 10:30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,530	42	15.4	17.2	-
05/21/1999 10:30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-
05/28/1999 10:05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7,810	41	56.7	94	-
06/04/1999 10:00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-
06/18/1999 9:55	12.1	25,900	1,130	10.8	6.0	59,800	1,560	486	0.7	2,010	639,000	0.1	1,030	90,800	108,000	7,660	393	397	10.3	3.0	14.9	1.5	683,000	3,590	15	22.7	23.2	28
06/18/1999 9:55	5.0	26,500	1,090	10.7	5.5	58,300	1,550	485	0.7	2,070	632,000	0.1	1,140	91,500	107,000	8,680	389	396	10.8	3.0	13.3	1.5	687,000	-	-			-
07/02/1999 10:39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,640	32	16	19.1	-
09/10/1999 9:45	11.0	9,240	279.0	11.2	2.9	34,100	564	189	2.9	564	272,000	0.1	1,090	62,100	61,400	2,820	154	326	2.2	5.6	2.0	0.8	299,000	1,760	61	9.35	9.32	36
Average =	14.3	11,388	363	15.1	3.5	38,882	717	211	2.1	731	328,364	0.2	1,063	71,609	61,409	4,164	178.1	366.7	70.9	4.8	13.2	1.7	345,273	2,315	56.7	14.9	18.0	37.2
Worst Water =	30.9	26,500	1,130	21.2	6.0	59,800	1,560	486	5.7	2,070	639,000	1.6	1,190	100,000	108,000	8,680	393.0	496.0	731.0	14.3	38.4	2.9	687,000	7,810	151.0	56.7	94.0	53.0

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9PU - No. 2 (White) Raise Pumps
Flow will be measured at 9KT by taking the difference between flow while pumps are on versus flow while pumps are off.

	Field Parameter					Total Metals, EPA CLP Lab Analytes																						
Sampling Date/Time	Temperature (deg C)	pH	Conductivity (umhos/cm)	Q* (gpm)	Comments	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)
11/13/1998 9:02	22.0	5.21	3,350	840	Pumps are on at 9 am	53.7	128	2.0	19.6	0.6	295,000	12.2	202	0.9	7.3	104,000	0.1	14,200	325,000	249,000	2,410	185	430	4.0	28.9	89.7	2.9	28,800
12/01/1998	-	-	-		No samples, pumps off		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
12/16/1998 10:30	22.7	5.04	3,300	840	Pumps are on	75.3	1,380	2.0	17.9	0.6	389,000	23.5	281	0.9	23.4	146,000	0.1	18,200	443,000	328,000	3,910	257	746	4.0	70.8	161	2.9	39,100
01/07/1999 10:15	24.5	5.5*	3,000	820	* pH paper used, pumps are on	13.9	884	33.3	13.2	1.0	346,000	17.1	209	44.6	31.8	133,000	0.2	15,700	372,000	326,000	5,520	200	602	3.0	122.0	unusable'	1.0	31,200
02/10/1999 9:44	20.2	5.36	3,600	780	-	75.3	205.0	3.7	21.4	0.3	372,000	12.0	259	2.4	141.0	131,000	0.1	17,700	414,000	327,000	3,960	238	681	3.5	67.9	146	1.4	34,900
02/26/1999 9:55	23.6	5.54	3,590	680	Pumps are on	107.0	90	3.7	21.5	0.3	396,000	16.7	292	10.5	45.8	144,000	0.1	20,000	457,000	347,000	4,840	262	686	3.5	75.4	121	1.4	36,300
04/02/1999 10:00	22.0	5.5	2,800	660	Pumps are on (Pumps were off when 9KT was sampled @ 9:30 am)	38.2	114	3.7	23.9	0.3	313,000	11.0	198	0.7	6.3	90,800	0.1	13,400	347,000	240,000	2,650	181	325	3.5	56.0	154	1.4	29,200
04/14/1999 10:25	22.9	5.55	3,700	700	Pumps are on	9.6	511	24.7	15.1	1.0	356,000	12.6	256	51.1	8.4	139,000	0.1	14,000	422,000	375,000	4,040	232	724	73.6	57.0	3	1.0	42,000
05/05/1999 10:40	23.4	5.45	3,820	800	Pumps are on (Pumps were off when 9KT was sampled @ 9:20 am)	54.0	145	4.2	18.5	0.2	397,000	11.1	274	0.7	5.7	141,000	4.0	19,000	434,000	324,000	2,910	240	623	2.1	79.1	214	1.5	34,100
05/21/1999	Pumps are off				No samples taken (Pumps off when 9KT sampled as well)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
05/28/1999	Pumps are off				No samples taken (Pumps must have been off when 9KT was sampled at 9:25 am as well. Flow balances with 9LA+9BS=9KT)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/04/1999	Pumps are off				No samples taken	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/18/1999 9:50	18.2	5.11	1,500	650	Pumps are on (Pumps off when 9KT was sampled)	33.6	1,470	101.0	25.9	0.2	240,000	60.8	116	0.7	42.2	45,600	0.1	6,900	210,000	129,000	1,060	120	641	2.1	8.6	18	1.5	37,600
07/02/1999 10:33	21.7	5.32	3,380	200	Pumps are on, may be throttling?	36.1	441	3.0	21.8	0.4	356,000	14.7	224	3.9	8.9	119,000	0.1	15,100	359,000	262,000	3,190	207	571	3.0	58.5	106	1.4	33,500
09/10/1999 9:50	23.3	5.28	3,850	858	Pumps are on (Forced 100% hydraulic closure at 9KT and calculated submerged workings pump rate to be 858 gpm)	51.2	303	3.0	8.8	0.4	424,000	12.9	277	10.6	2.5	163,000	0.1	20,100	446,000	381,000	5,810	251	805	3.0	80.5	149	1.4	37,500
Average =	22.2	5.3	3,263	712		49.8	515.6	16.8	18.9	0.5	353,091	18.6	235.3	11.5	29.4	123,309	0.5	15,845	384,455	298,909	3,664	215.7	621.3	9.6	64.1	116.2	1.6	34,927
Worst Water =	24.5	5.0	3,850	858		107.0	1,470	101.0	25.9	1.0	424,000	60.8	292.0	51.1	141.0	163,000	4.0	20,100	457,000	381,000	5,810	262.0	805.0	73.6	122.0	214.0	2.9	42,000

NOTES: unusable = The data are unusable. (Analyte may or may not be present). Reported in Data Validation Reports by EPA.

* The pump flow rate is determined by looking at the KT flow meter strip chart and calculating the flow difference when the pumps are on versus when they are off during that time period.

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9PU - No. 2 (White) Raise Pumps
Flow will be measured at 9KT by taking the difference between flow while pumps are on versus flow while pumps are off.

Sampling Date/Time	Dissolved Metals, EPA CLP Lab Analytes																							QAL Lab Analytes				
	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)	Sulfate (mg/L)	TSS (mg/L)	Lime Demand / Solids Formed (lbs/1,000 gal)		Dissolved Ferrous Iron (mg/L)
11/13/1998 9:02	58.7	30.1	2.0	21.0	0.6	318,000	13.4	219	0.9	4.8	108,000	0.1	15,100	347,000	263,000	2,750	199	286	4.0	33.0	96.1	2.9	31,100	2,790	< 10	5.01	6.43	131
12/01/1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
12/16/1998 10:30	73.3	790.0	2.0	18.6	0.6	378,000	23.4	276	0.9	25.9	140,000	0.1	17,800	442,000	326,000	4,370	251	598	4.0	68.9	152	2.9	40,100	3,840	51	8.35	12.5	165
01/07/1999 10:15	6.5	345.0	26.0	11.3	1.0	290,000	15.7	179	32.2	31.2	112,000	0.2	12,900	321,000	250,000	4,810	163	436	3.0	65.9	unusable'	1.0	27,700	3,840	74	10.7	14.7	151
02/10/1999 9:44	72.8	64.0	3.7	24.1	0.3	349,000	13.7	251	2.8	5.0	123,000	0.1	17,300	400,000	303,000	3,970	233	494	3.5	62.5	129	1.4	33,100	3,340	71	7.68	10.2	134
02/26/1999 9:55	110.0	12.8	3.7	23.7	0.3	403,000	16.0	297	10.6	0.8	147,000	0.1	20,900	469,000	351,000	5,020	268	587	3.5	77.8	128	1.4	36,400	3,580	37	10.3	12.4	151
04/02/1999 10:00	36.8	59.8	3.7	30.6	0.3	323,000	12.2	213	0.7	10.1	93,200	0.9	14,700	373,000	249,000	2,870	198	133	3.5	60.6	174	1.4	30,500	2,620	35	7.34	10.7	95
04/14/1999 10:25	13.1	356.0	21.2	15.2	1.0	362,000	12.9	264	26.1	4.2	138,000	0.1	15,000	432,000	398,000	4,200	235	612	70.5	60.0	60	1.0	41,100	3,670	36	10.3	12	156
05/05/1999 10:40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,750	19	10.3	14.1	-
05/21/1999	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-
05/28/1999	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-
06/04/1999	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-
06/18/1999 9:50	28.4	364.0	63.3	24.5	0.2	216,000	55.6	107	0.7	34.6	35,900	0.1	6,650	195,000	118,000	1,080	111	308	2.1	8.5	20	1.5	33,800	1,780	53	4.01	4.75	39
07/02/1999 10:33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,280	18	9.35	12.2	-
09/10/1999 9:50	52.6	244.0	36.4	15.6	0.4	452,000	19.4	351	5.4	2.0	204,000	0.1	26,400	536,000	466,000	6,390	321	769	2.2	81.0	2	0.8	52,000	4,310	25	12	16.7	193
Average =	50.2	251.7	18.0	20.5	0.5	343,444	20.3	239.7	8.9	13.2	122,344	0.2	16,306	390,556	302,667	3,940	219.9	469.2	10.7	57.6	95.1	1.6	36,200	3,345	41.9	8.7	11.5	135.0
Worst Water =	110.0	790.0	63.3	30.6	1.0	452,000	55.6	351.0	32.2	34.6	204,000	0.9	26,400	536,000	466,000	6,390	321.0	769.0	70.5	81.0	174.0	2.9	52,000	4,310	74.0	12.0	16.7	193.0

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

11VD - 11 Veral Dam
4x18 cutthroat flume installed on 3/19/99; St = 0.762 ft, C = 1.975, n1 = 2.15

	Field Parameter								Total Metals, EPA CLP Lab Analytes																						
Sampling Date/Time	Temperature (deg C)	pH	Conductivity (umhos/cm)	Ha (ft)	Hb (ft)	S	Free Flow Q (gpm)	Comments	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)
03/19/1999	13	7.03	160	0.19	-	-	24.94	temporary place	1.3	78.4	62.1	149.0	0.3	34,400	0.5	3.2	1.0	39.4	16,100	0.2	1,150	4,550	2,510	773	4.2	254	3.5	3.1	4.9	1.4	313

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

11VD - 11 Veral Dam
4x18 cutthroat flume installed on 3/19/99; St = 0.762 ft, C = 1.975, n1 = 2.15

	Dissolved Metals, EPA CLP Lab Analytes																							QAL Lab Analytes				
Sampling Date/Time	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)	Sulfate (mg/L)	TSS (mg/L)	Lime Demand / Solids Formed (lbs/1,000 gal)		Dissolved Ferrous Iron (mg/L)
03/19/1999	0.7	69.9	3.7	130	0.3	34,500	0.3	2.0	1.9	10.2	1,860	0.2	1,120	4,520	1,970	848.0	3.1	1.9	3.5	3.1	4.9	1.4	112	46	24	0.67	1.11	< 10

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9BS - Barney Switch
4x36 cutthroat flume installed in 10/98, 8*36 cutthroat flume used previously; St = 0.66 ft, C = 1.459, n1 = 1.84

Sampling Date/Time	Field Parameter: Temperature (deg C)	pH	Conductivity (umhos/cm)	Ha (ft)	Hb (ft)	S	Free Flow Q (gpm)	Comments
10/27/1998	**Flume Installation**		-	-	-	-		flume needs leveling
11/13/1998	10.4	6.01	1,400	0.35	0.17	0.49	94.9	-
12/01/1998 11:40	10.6	6.06	520	0.42	-	-	132.7	-
12/01/1998 11:40	9BS Field Duplicate (9FE) for CLP Lab							-
12/16/1998 12:26	10.6	5.94	1,530	0.45	0.15	0.33	150.7	-
12/16/1998 12:26	9BS Field Duplicate (9FE)							-
01/07/1999 12:15	10.5	6.1*	318	0.47	-	-	163.2	pH paper usec
02/10/1999 12:30	9.8	6.91	410	0.5	-	-	182.9	-
02/26/1999 12:15	10.8	6.91	382	0.52	0.12	0.23	193.1	-
04/02/1999 12:19	10.4	6.47	490	0.64	-	-	288.1	-
04/14/1999 9:55	10.5	6.71	300	0.58	-	-	240.3	-
04/14/1999 9:55	9BS Field Duplicate (9FE) for CLP Lab							
05/05/1999 12:35	10	7.42	412	0.56	-	-	225.3	-
05/21/1999 12:20	10.3	6.8	550	0.44	-	-	144.6	-
05/28/1999 13:00	10.3	4.99	368	0.5	-	-	182.9	-
06/18/1999 12:55	-	-	-	0.38	-	-	110.4	-
07/02/1999 10:04	10.9	5.84	338	0.47	-	-	163.2	-
09/10/1999 12:20	10.9	5.75	382	0.42	-	-	132.7	-
Average =	10.5	6.3	569				171.8	
Worst Water =	10.9	5.0	1,530				288.1	

Sampling Date/Time	Total Metals EPA CLP Lab Analytes: Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)
10/27/1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
11/13/1998	2.5	65.7	3.0	68.2	0.6	18,200	13.1	14.9	0.9	9.1	3,100	0.1	1,100	35,800	11,500	872	18.3	400	4.0	1.9	3.6	2.9	4,420
12/01/1998 11:40	4.2	145.0	2.0	64.1	0.6	20,300	19.5	19.1	0.9	13.4	2,940	0.1	1,210	50,400	15,400	1,330	22.7	694	4.0	2.8	3.6	2.9	4,550
12/01/1998 11:40	4.3	144.0	2.0	63.3	0.6	20,700	20.3	18.9	0.9	13.9	2,550	0.1	1,180	50,600	15,400	1,250	23.9	585	4.0	2.8	3.6	2.9	4,802
12/16/1998 12:26	2.1	104.0	4.6	66.8	0.6	19,200	18.9	19.6	0.9	10.9	2,160	0.1	1,160	43,200	14,600	1,200	24.2	632	4.0	3.8	3.6	2.9	4,180
12/16/1998 12:26	3.7	101.0	2.0	65.4	0.6	18,900	18.8	19.3	0.9	11.9	2,110	0.1	1,170	43,500	14,600	1,140	23.8	621	4.0	1.9	3.6	2.9	4,260
01/07/1999 12:15	2.0	92.3	4.5	82.9	1.0	19,300	13.4	13.9	1.7	23.6	2,430	0.2	857	34,100	11,200	1,720	17.2	452	3.0	4.0	6.6	1.0	3,490
02/10/1999 12:30	4.1	100.0	3.7	113	0.3	20,200	16.9	16.1	1.7	14.7	3,880	0.1	1,270	40,400	12,600	1,310	20.3	550	3.5	3.1	4.9	1.4	4,570
02/26/1999 12:15	4.1	159.0	3.7	102	0.3	21,200	21.0	20.0	1.3	33.6	4,240	0.1	1,300	48,400	15,200	1,260	24.2	843	3.5	3.1	4.9	1.4	4,120
04/02/1999 12:19	2.8	168.0	4.2	86	0.3	20,700	26.0	16.7	0.8	35.5	3,000	0.1	1,300	55,500	14,900	1,020	21.0	1,180	3.5	3.1	7.3	1.4	4,300
04/14/1999 9:55	2.0	116.0	4.9	103	1.0	21,200	20.7	14.5	5.0	18.2	5,960	0.1	1,080	52,700	14,200	1,260	20.5	1,240	8.2	3.0	3.0	1.0	4,370
04/14/1999 9:55	2.4	117.0	4.9	104	1.0	21,300	20.7	15.4	5.2	17.9	5,700	0.1	1,050	53,400	14,400	1,210	21.3	1,230	8.7	3.0	3.0	1.0	4,850
05/05/1999 12:35	2.6	180.0	4.4	80	0.2	18,300	24.0	13.0	0.8	20.9	4,510	7.8	1,140	53,300	13,100	950	16.2	1,690	2.1	unusable	7.0	1.5	3,590
05/21/1999 12:20	3.7	169.0	4.2	85	0.2	19,200	24.1	13.6	0.7	16.1	2,120	9.5	1,480	52,800	13,400	1,590	19.4	1,220	2.1	3.0	5.6	1.5	3,700
05/28/1999 13:00	2.9	122.0	6.0	75	1.0	17,800	22.5	12.6	1.5	20.4	2,210	0.2	978	46,000	11,900	1,570	16.6	1,250	5.0	4.0	10.0	4.5	3,320
06/18/1999 12:55	4.0	108.0	4.2	99	0.2	21,900	23.4	16.6	0.7	13.2	2,730	0.1	1,420	50,800	14,500	1,260	21.6	1,150	2.1	unusable	5.6	1.5	4,250
07/02/1999 10:04	1.4	101.0	3.0	83	0.4	20,000	17.9	14.4	1.0	9.3	2,360	0.1	1,150	40,400	12,100	915	18.9	767	3.0	2.3	3.3	1.4	3,700
09/10/1999 12:20	7.3	34.2	3.0	67	0.4	18,900	15.9	17.7	1.0	8.5	2,380	0.1	1,210	34,700	11,400	1,220	21.6	517	3.0	2.3	3.3	1.4	4,280
Average =	3.3	119.2	3.8	82.8	0.6	19,841	19.8	16.3	1.5	17.1	3,199	1.1	1,180	46,235	13,553	1,240	20.7	884	4.0	2.9	4.9	2.0	4,162
Worst Water =	7.3	180.0	6.0	113.0	1.0	21,900	26.0	20.0	5.2	35.5	5,960	9.5	1,480	55,500	15,400	1,720	24.2	1,690	8.7	4.0	10.0	4.5	4,850

NOTES: unusable = The data are unusable. (Analyte may or may not be present). Reported in Data Validation Reports by EPA.

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9BS - Barney Switch
4x36 cutthroat flume installed in 10/98, 8*36 cutthroat flume used previously; St = 0.66 ft, C = 1.459, n1 = 1.84

	Dissolved Metals, EPA CLP Lab Analytes																							QAL Lab Analytes				
Sampling Date/Time	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)	Sulfate (mg/L)	TSS (mg/L)	Lime Demand / Solids Formed (lbs/1,000 gal)		Dissolved Ferrous Iron (mg/L)
10/27/1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
11/13/1998	3.2	334.0	8.2	69.1	0.6	19,800	46.1	21.4	0.9	22.9	20,900	0.1	1,170	38,600	14,300	464	23.9	73.7	4.0	1.9	3.7	2.9	20,700	202	< 10	1.00	0.61	< 10
12/01/1998 11:40	4.6	71.2	2.0	62.7	0.6	20,800	19.0	19.2	0.9	5.2	1,250	0.1	1,200	50,200	15,400	1,740	22.3	114	4.0	2.0	3.6	2.9	4,620	273	< 10	1.00	0.74	< 10
12/01/1998 11:40	4.9	20.4	2.0	64.1	0.6	21,100	19.7	20.3	1.0	3.8	1,440	0.1	1,220	51,300	15,600	1,620	23.5	139	4.0	1.9	3.6	2.9	4,720	-	-		-	-
12/16/1998 12:26	2.0	20.4	2.3	68.3	0.6	19,700	18.9	20.2	0.9	5.6	1,410	0.1	1,190	44,200	14,800	1,550	24.4	265	4.0	3.8	3.6	2.9	4,180	226	< 10	0.67	0.51	< 10
12/16/1998 12:26	2.9	43.7	2.0	64.2	0.6	19,300	18.8	19.5	0.9	7.1	1,890	0.1	1,120	44,000	14,700	1,300	24.0	217	4.0	1.9	4.5	2.9	4,510	254	< 10	1.00	0.97	< 10
01/07/1999 12:15	2.0	46.5	4.0	81.7	1.0	19,700	13.3	13.7	1.0	14.9	1,720	0.2	829	34,600	11,000	1,650	18.1	159	3.0	4.0	unusable	1.0	3,390	181	< 10	1.00	0.81	< 10
02/10/1999 12:30	3.0	37.1	3.7	112.0	0.3	19,900	14.7	14.8	0.7	20.1	1,950	0.1	1,220	39,700	12,400	1,250	19.3	135	3.5	3.5	5.2	1.4	3,470	208	< 10	0.67	0.45	< 10
02/26/1999 12:15	2.3	23.3	3.7	106.0	0.3	21,300	20.8	19.5	0.8	28.1	2,180	0.1	1,280	48,900	15,200	1,220	24.6	182	3.5	3.1	4.9	1.4	4,050	259	< 10	0.67	0.71	< 10
04/02/1999 12:19	2.1	20.0	3.7	79.0	0.3	18,400	23.4	14.8	0.7	7.8	1,150	1.5	1,220	50,500	13,300	1,150	21.6	609	3.5	unusable	5.6	1.4	3,660	279	< 10	1	0.82	< 10
04/14/1999 9:55	2.0	9.0	2.0	102.0	1.0	20,900	19.9	14.4	1.9	3.0	1,420	0.1	1,010	51,900	14,000	1,260	19.7	266	5.7	3.0	3.0	1.0	4,160	259	20	0.67	0.44	< 10
04/14/1999 9:55	2.0	23.0	2.0	104.0	1.0	21,100	20.1	14.9	2.3	3.0	1,500	0.1	1,020	53,100	14,200	1,270	19.6	294	5.8	3.0	3.0	1.0	4,420	-	-			-
05/05/1999 12:35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	314	14	0.67	0.45	-
05/21/1999 12:20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	244	< 10	0.67	0.49	-
05/28/1999 13:00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	257	< 10	0.67	0.54	-
06/18/1999 12:55	1.9	30.2	4.2	90.5	0.2	18,900	20.6	13.8	0.7	8.9	1,610	0.1	1,320	45,400	12,700	1,000	18.4	768	2.1	3.0	5.6	1.5	3,650	236	11	0.67	0.34	<10
07/02/1999 10:04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	227	< 10	0.67	0.46	-
09/10/1999 12:20	0.8	43.2	2.1	70.8	0.1	19,800	16.0	18.0	0.3	3.8	1,670	0.1	1,290	36,800	12,000	1,040	23.2	302	2.2	1.8	2.0	0.8	4,010	216	< 10	0.33	0.38	< 10
Average =	2.6	55.5	3.2	82.6	0.6	20,054	20.9	17.3	1.0	10.3	3,084	0.2	1,161	45,323	13,815	1,270	21.7	271.1	3.8	2.7	4.0	1.8	5,349	242.3	15.0	0.8	0.6	< 10
Worst Water =	4.9	334.0	8.2	112.0	1.0	21,300	46.1	21.4	2.3	28.1	20,900	1.5	1,320	53,100	15,600	1,740	24.6	768.0	5.8	4.0	5.6	2.9	20,700	314.0	20.0	1.0	1.0	< 10

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9KT - Kellogg Tunnel
12" Parshall flume operating as of 10/98; W= 1', K = 1795, n = 1.522 (for FREE FLOW, recommended min Q=54gpm @ 0.1ft; recommended max Q=7240gpm @ 2.5ft)

	Field Parameter						Total Metals, EPA CLP Lab Analytes																						
Sampling Date/Time	Temperature (deg C)	pH	Conductivity (umhos/cm)	Free Flow Q (gpm)	Ha (ft)	Comments	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)
11/13/1998 8:02	11	2.93	1,100	495.1	0.429	Pumps are off until 9 am	10.4	3,420	59.4	27.8	1.1	33,000	216	84.2	0.9	187	91,300	0.1	1,370	56,100	34,700	130	77.2	327	4.0	1.9	11.4	2.9	116,000
11/13/1998 8:02	9KT Field Duplicate (29KT)						9.2	3,420	63.1	27.7	1.1	27,200	219	81.0	0.9	186	90,500	0.1	1,120	50,400	31,000	130	74.3	327	4.0	1.9	7.1	2.9	116,000
11/13/1998 8:02	Lab QC Duplicate						8.7	3,550	65.6	30.1	1.1	28,400	220	82.9	0.9	192	91,600	0.1	1,190	52,600	31,600	130	73.8	336	4.0	1.9	10.8	2.9	123,000
12/01/1998	10.8	2.57	1,150	532.4	0.45	Pumps are off	12.3	2,840	54.9	29.8	1.1	27,200	211	73.7	2.7	148	78,000	0.1	1,210	47,900	31,100	4,110	67.8	416	4.0	unusable'	4.1	2.9	96,500
12/17/1998 12:45	NM	2.85	1,100	625.0	0.50	* pH, EC measured during sample pres. & packaging	11.0	3,210	60.4	29.1	1.0	27,500	226	76.8	0.9	180	95,000	0.1	1,130	51,900	31,200	1,120	70.9	429	4.0	1.9	10.5	2.9	115,000
12/17/1998 12:45	9KT Field Duplicate (9FE) for CLP Lab					Pumps are off	10.7	3,160	58.8	28.3	1.0	27,600	225	76.4	0.9	178	94,500	0.1	1,090	51,200	31,200	872	72.7	420	4.0	1.9	10.3	2.9	112,000
01/07/1999 9:02	16	NM*	2,300	1,351.8	0.83	* pH meter not stable for readings, pumps are on	2.0	2,110	65.2	24.1	1.2	212,000	119	164.0	24.2	115	131,000	0.2	9,010	238,000	193,000	4,220	149.0	560	3.0	58.1	unusable'	1.0	68,200
01/07/1999 9:02	9KT Field Duplicate (9FE)						2.4	1,890	65.2	20.9	1.0	189,000	103	139.0	18.8	110	118,000	0.2	7,780	212,000	180,000	3,800	134.0	514	3.0	50.9	unusable'	1.0	58,600
02/10/1999 9:05	14	3.24	2,300	1,229.8	0.78	Pumps are ON	42.3	2,140	50.8	32.3	0.8	197,000	144	172.0	2.9	119	128,000	0.1	8,950	233,000	177,000	2,630	161.0	544.0	3.5	28.2	63.4	1.4	86,200
02/26/1999 8:50	15.5	3.77	2,030	1,364.2	0.835	Pumps are ON	51.8	2,200	50.6	31.0	0.6	193,000	150.0	170.0	7.2	124.0	127,000	0.1	9,100	230,000	186,000	3,110	155.0	506.0	3.5	30.9	46.2	1.4	91,600
02/26/1999 8:50	9KT Field Duplicate (9FE) for CLP Lab						53.0	2,240	55.5	31.5	0.6	197,000	155.0	177.0	7.2	121.0	130,000	0.1	9,450	238,000	186,000	3,430	161.0	524.0	3.5	29.8	46.6	1.4	92,200
04/02/1999 9:30	10.6	3.3	1,210	824.9	0.6	Pumps are OFF	15.0	6,200	153.0	32.7	2.0	34,800	397.0	98.8	0.7	291.0	184,000	0.1	1,160	77,600	55,100	106.0	93.0	654.0	3.5	3.1	20.5	1.4	186,000
04/02/1999 9:30	9KT Field Duplicate (9FE)						17.5	6,650	164.0	36.2	2.0	36,200	426.0	105.0	1.0	339.0	198,000	0.5	1,290	84,100	54,900	106.0	100.0	694.0	3.5	unusable'	19.6	1.4	183,000
04/14/1999 9:00	15.2	3.42	2,220	1,426.8	0.86	Pumps are ON	6.3	4,060	132.0	31.5	1.4	178,000	233.0	173.0	19.1	227.0	166,000	0.3	6,330	226,000	191,000	2,280	157	644	304	4.3	3.0	1.0	137,000
05/05/1999 9:20	14.5	3.07	1,980	998.0	0.68	Pumps are OFF	31.3	4,890	462.0	58.8	1.3	148,000	321.0	183.0	2.3	394.0	235,000	7.6	6,290	186,000	143,000	104.0	163.0	2,520	9.2	19.2	66.9	1.5	143,000
05/21/1999 9:50	14.4	3.42	1,780	931.8	0.65	Pumps are OFF	29.7	5,320	484.0	52.1	1.1	115,000	300.0	155.0	4.8	321.0	271,000	9.3	5,560	155,000	121,000	3,170	144.0	1,570	9.2	3.0	16.1	1.5	159,000
05/28/1999 9:25	18	2.76	3,620	1,426.8	0.86	Pumps are OFF	27.2	39,100	3,600	23.3	7.8	63,300	2,070	732.0	29.8	3,910	912,000	0.2	999.0	110,000	128,000	2,180	477.0	630.0	5.0	4.0	7.0	24.0	715,000
05/28/1999 9:25	9KT Field Duplicate (9FE)						26.6	37,900	3,510	22.8	7.7	61,400	2,010	709.0	27.8	3,790	885,000	0.2	970.0	107,000	123,000	2,100	464.0	635.0	5.0	4.0	7.0	26.1	683,000
06/03/1999 8:30	-	-	-			Ferrous iron analysis only; no field measurements	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/04/1999	-	-	-	1,401.7	0.85	No samples taken; Pumps are OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/18/1999 9:10	14.6	3.24	1,960	1,020.5	0.69	Pumps OFF	18.4	8,800	339.0	25.6	1.7	107,000	514.0	200.0	1.2	653.0	182,000	0.1	3,280	119,000	103,000	104.0	175.0	605.0	3.8	unusable'	6.1	1.5	228,000
07/02/1999 9:15	16.3	3.05	2,610	1,351.8	0.83	Pumps on	27.3	6,570	234.0	18.6	1.5	211,000	387.0	242.0	4.1	439.0	208,000	0.1	8,780	231,000	181,000	4,010	212.0	521.0	3.0	38.3	61.5	1.4	186,000
07/02/1999 9:15	9KT Field Duplicate (9FE)					Pumps on	28.7	6,710	237.0	19.4	1.5	219,000	401.0	251.0	3.9	451.0	215,000	0.1	8,830	237,000	184,000	3,900	221.0	534.0	3.0	41.0	66.2	1.4	188,000
09/10/1999 9:15	17.3	3.12	2,580	1,376.6	0.84	Pumps on	33.8	3,030	81.0	21.1	0.8	255,000	177.0	216.0	7.1	173.0	158,000	0.1	12,000	294,000	244,000	7,450	197.0	664.0	3.0	46.1	91.5	1.4	110,000
09/10/1999 9:15	9KT Field Duplicate (9FE)						33.5	2,640	67.7	18.7	0.7	226,000	156.0	192.0	7.0	152.0	140,000	0.1	10,300	258,000	213,000	6,590	174.0	583.0	3.0	40.6	76.9	1.4	97,400
Average =	14.5	3.1	1,995.7	1,090.5			22.1	7,046	439.7	29.3	1.7	122,330	407.8	198.0	7.7	556.5	214,300	0.9	5,095	154,165	124,078	2,425	164.1	659.0	17.2	20.6	31.1	3.8	177,857
Worst Water =	18.0	2.6	3,620.0	1,426.8			53.0	39,100	3,600	58.8	7.8	255,000	2,070	732.0	29.8	3,910	912,000	9.3	12,000	294,000	244,000	7,450	477.0	2,520	304.0	58.1	91.5	26.1	715,000

NOTES: unusable = The data are unusable. (Analyte may or may not be present). Reported in Data Validation Reports by EPA.

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

9KT - Kellogg Tunnel
12" Parshall flume operating as of 10/98; W= 1', K = 1795, n = 1.522 (for FREE FLOW, recommended min Q=54gpm @ 0.1ft; recommended max Q=7240gpm @ 2.5ft)

Sampling Date/Time	Dissolved Metals, EPA CLP Lab Analytes																							QAL Lab Analytes				
	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)	Sulfate (mg/L)	TSS (mg/L)	Lime Demand / Solids Formed (lbs/1,000 gal)		Dissolved Ferrous Iron (mg/L)
11/13/1998 8:02	10.2	3,440	27.1	67.0	2.2	28,700	219	91.9	3.0	193.0	83,000	0.1	1,150	51,000	31,700	130	91	317	5.9	1.9	7.4	5.1	119,000	773	32	4.01	3.64	25
11/13/1998 8:02	10.6	3,450	33.7	28.8	1.4	28,800	222	83.9	0.9	184.0	88,300	0.1	1,140	51,300	32,100	130	75.3	409	4.0	1.9	7.7	2.9	120,000	750	35	4.01	4.04	31
11/13/1998 8:02	10.0	3,440	26.0	29.5	1.4	29,500	223	85.1	0.9	188.0	84,500	0.1	1,180	51,900	32,300	130	76.2	324	4.0	1.9	8.1	2.9	120,000	798	32	4.33	3.90	25
12/01/1998	10.1	3,020	19.7	33.2	1.1	27,800	217	72.7	1.6	172.0	70,700	0.1	1,330	48,800	31,800	4,570	67.7	397	4.0	1.9	3.6	2.9	98,900	499	43	3.67	3.51	20
12/17/1998 12:45	10.9	3,410	34.8	30.6	1.4	29,500	236	79.8	0.9	200.0	93,400	0.1	1,320	52,900	32,600	913	75.3	440	4.0	1.9	9.9	2.9	117,000	790	64	4.01	4.05	25
12/17/1998 12:45	11.1	3,450	33.0	30.9	1.4	29,500	236	80.6	1.4	189.0	93,200	0.1	1,310	53,100	32,500	903	74.6	437	4.0	1.9	9.3	2.9	117,000	-	-			-
01/07/1999 9:02	2.5	1,900	13.9	25.9	1.4	193,000	104	142	9.3	98.1	80,500	0.2	8,090	216,000	150,000	3,900	131	444	3.0	31.1	unusable'	1.0	60,900	2,070	280	7.34	8.43	73
01/07/1999 9:02	2.0	1,680	11.8	23.0	1.2	170,000	93	128	7.6	91.5	71,500	0.2	6,690	192,000	149,000	3,440	117	389	3.0	25.9	unusable'	1.0	54,800	2,130	194	8.35	9.45	70
02/10/1999 9:05	40.8	2,040	3.7	38.3	0.9	189,000	142	168	3.0	124.0	79,000	0.1	8,590	227,000	190,000	2,940	158	492	3.5	28.9	60.7	1.4	92,800	1,780	218	6.34	6.96	50
02/26/1999 8:50	53.4	2,240	3.7	38.1	0.7	200,000	157.0	179.0	7.1	136.0	83,800	0.1	9,560	241,000	191,000	3,710	164.0	493.0	3.5	32.2	42.4	1.4	94,500	1,940	190	6.68	8.48	56
02/26/1999 8:50	53.4	2,260	3.7	41.9	0.7	199,000	156.0	179.0	7.5	210.0	83,600	0.1	9,390	240,000	184,000	3,760	164.0	495.0	3.5	31.1	46.6	1.4	92,800	1,960	215	6.34	6.62	59
04/02/1999 9:30	15.7	6,440	139.0	36.5	2.0	34,500	408.0	101.0	0.7	309.0	182,000	1.5	1,300	80,700	54,400	106.0	98.5	607.0	3.5	unusable'	22.0	1.4	182,000	1,250	49	7.01	7	< 10
04/02/1999 9:30	15.9	6,640	145.0	35.7	2.1	35,900	423.0	104.0	0.7	331.0	188,000	0.6	1,320	83,100	56,100	106.0	103.0	635.0	3.5	unusable'	22.0	1.4	187,000	-	-			-
04/14/1999 9:00	6.9	3,910	21.0	31.3	1.7	179,000	231.0	176.0	20.0	220.0	101,000	1.0	6,540	229,000	199,000	2,510	158.0	614.0	296.0	60.0	60.0	1.0	131,000	2,340	216	8.35	7.68	11
05/05/1999 9:20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,850	438	6.68	6.47	-
05/21/1999 9:50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,660	505	6.34	6.25	-
05/28/1999 9:25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,310	40	40.1	42.6	-
05/28/1999 9:25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					-
06/03/1999 8:30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			45
06/04/1999	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			-
06/18/1999 9:10	16.4	10,300	238.0	29.6	2.1	123,000	595.0	229.0	0.7	771.0	185,000	0.1	3,990	137,000	98,600	104.0	198.0	707.0	2.1	3.8	8.8	1.5	242,000	1,980	116	9.01	8.49	14
07/02/1999 9:15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,760	178	8.68	9.5	-
07/02/1999 9:15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,650	203	9.01	10	-
09/10/1999 9:15	21.6	2,560	15.4	19.8	1.0	206,000	153.0	190.0	1.4	151.0	92,000	0.1	10,500	246,000	188,000	2,560	171.0	512.0	2.2	23.2	2.0	0.8	89,700	2,510	160	6.34	7.12	70
09/10/1999 9:15	24.9	2,750	15.8	21.8	1.0	220,000	166.0	204.0	3.2	164.0	97,900	0.1	11,200	265,000	204,000	2,880	185.0	550.0	2.2	23.8	2.0	0.8	97,400	-	-			-
Average =	18.6	3,702	46.2	33.1	1.4	113,129	234.1	134.9	4.1	219.5	103,376	0.3	4,976	145,047	109,241	1,929	124.0	486.0	20.7	18.1	20.8	1.9	118,635	1,884	168.8	8.2	8.6	41.0
Worst Water =	53.4	10,300	238.0	67.0	2.2	220,000	595.0	229.0	20.0	771.0	188,000	1.5	11,200	265,000	204,000	4,570	198.0	707.0	296.0	60.0	60.7	5.1	242,000	5,310	505.0	40.1	42.6	73.0

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

1DC - 1 Level Discovery Cut, 2BA - 2 Level Buckeye Adit, 3UTZ - 3 Level Utz, 7LD - 7 Level Dam, 9RD - 9 Level Ramsey Drive, 9MG - 9 Level Morgan Drive, 9DR - 9 Level Dull Raise, 9CV - 9Level Cherry Vent Raise, 9BX - 9 Level Bailey Cross Cut, 10PU - 10 Level Pumps, 2SU - Sullivan No. 2 water going down raise, 6DP - 6 Level Last Draw Point, 6HS - 6 Level Drainage from Stope, 6PD - 6 Level Pond before main draw points

		Field Parameter				Total Metals: EPA CLP Lab Analytes																						
Sampling Date/Time	Sampling Location	Temperature (deg C)	pH	Conductivity (umhos/cm)	Comments	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)
01/27/1999 10:57	1DC	4	4.42	1,410	-	39.1	4,110	3.7	3.6	1.3	17,200	490	45.6	0.7	78	483,000	0.1	775	54,400	102,000	2,130	74.6	1,310	3.5	31.1	17.7	1.4	72,100
01/27/1999 8:58	2BA	5	5.15	72	-	0.84	459	6.0	3.0	0.3	2,200	0.89	2.6	0.7	185	172	0.1	838	628	71.9	520	3.9	59.4	3.5	3.1	4.9	1.4	121
01/27/1999 8:58	2BA	Field Duplicate (1FE) for both Labs				561	587	9.6	3.4	0.3	2,270	4.4	2.4	0.7	200	886	0.1	795	616	72.3	561	3.4	55.8	3.5	3.1	4.9	1.4	911
01/27/1999 9:57	3UTZ	5	2.33	7,100		53.6	312,000	7,580	6.9	7.1	7,210	12,400	371	55.4	34,200	2,900,000	0.79	106	35,800	8,740	244,000	463	63.2	143	76.7	4.9	24.6	3,210,000
2/10/99	9TP (Field Blank)	Commercially prepared HPLC water				0.7	12.8	3.7	1.5	0.3	95.8	0.3	1.6	0.7	55.6	33.3	0.1	18.6	23.8	24.1	106	3.1	2.8	3.5	3.1	4.9	1.4	75.5
03/01/1999 7:20	7LD	10.2	4.53	101	-	0.7	679	31.7	4.6	0.3	3,320	0.5	7.0	0.7	17.4	14,500	0.1	713	933	1,180	608	5.0	33	3.5	3.1	4.9	1.4	378
05/28/1999 12:15	9RD	16.8	6.67	420	-	4.4	61.9	21.9	13	1.3	31,700	11.0	2.4	4.0	24.8	27,800	0.2	1,090	35,300	18,400	1,500	2.5	283	5.0	4.0	7.1	7.9	4,570
05/28/1999 12:25	9MG	16.7	5.95	820	-	10.0	86.8	6.0	6.2	1.1	31,700	32.7	7.2	9.0	11.3	5,750	0.2	1,330	91,700	38,100	2,520	17.1	808	5.0	9.3	7.0	14.1	12,900
05/28/1999 12:40	9DR	17.6	5.53	4,390	-	100	607	6.0	5.2	1.9	198,000	155	132	86.7	14.2	70.6	0.2	5,780	888,000	400,000	5,360	172	463	5.0	78.1	7.0	1.0	149,000
05/29/1999 7:12	9CV	17.4	6.15	251	-	1.0	34.5	20.4	7.8	1.0	9,990	1.0	18.1	1.0	13.9	52,300	0.2	1,080	3,540	5,010	978	8.2	2.0	5.0	4.0	11.0	2.5	952
06/04/1999	9BX	13	7.18	145	No samples ~17.45 gpm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
06/18/1999 9:45	10PU	16.6	4.4	2,800	Pumps ON	54	105	4	9	0	104,000	66	67	0.7	27	1,570	0.1	2,760	503,000	199,000	1,940	93	886	2	22	43	2	42,100
07/06/1999 16:43	2SU	-	4.6	150	-	2.1	459	3	28.1	0.4	2,430	6	5.5	1.7	3.3	8,810	0.1	830	3,910	6,000	927	5.6	781	3	2.3	3.3	1.4	1,500
07/06/1999 14:58	6DP	-	3.8	1,300	-	8.9	69.9	3	7	0.4	43,200	88	29.7	1.6	4.8	5,150	0.1	1,520	145,000	74,300	962	47.3	644	3	5.1	13.2	1.4	42,200
07/06/1999 14:50	6HS	-	5.3	1,600	-	20.8	127	3	1.7	0.4	47,100	106	50.9	1.5	3.5	662	0.1	1,870	187,000	178,000	1,280	77.9	1,290	3	24.9	53.7	1.4	48,800
07/06/1999 14:27	6PD	-	3.8	380	-	8.6	70.5	3	10	0.4	24,500	22.2	19.3	1.9	2.5	7,940	0.1	2,010	58,300	69,900	1,590	44.9	449	3	5.8	11.3	1.4	13,000
07/27/1999	9TP (Field Blank)	Commercially prepared HPLC water				1.4	12	3	0.7	0.4	116	0.5	2.2	1.0	8.0	27.1	0.1	86.7	14.4	5.9	153	2.5	1.7	3.0	2.3	3.3	1.4	25.6

NOTES: unusable = The data are unusable. (Analyte may or may not be present). Reported in Data Validation Reports by EPA.

Bunker Hill Mine Water Management
New Data Collected during 1998/1999 AMD Monitoring Program

1DC - 1 Level Disc 1DC - 1 Level Discovery Cut, 2BA - 2 Level Buckeye Adit, 3UTZ - 3 Level Utz, 7LD - 7 Level Dam, 9RD - 9 Level Ramsey Drive, 9MG - 9 Level Morgan Drive, 9DR - 9 Level Dull Raise, 9CV - 9Level Cherry Vent Raise, 9BX - 9 Level
10PU - 10 Level PuBailey Cross Cut, 10PU - 10 Level Pumps, 2SU - Sullivan No. 2 water going down raise, 6DP - 6 Level Last Draw Point, 6HS - 6 Level Drainage from Stope, 6PD - 6 Level Pond before main draw points

	Dissolved Metals, EPA CLP Lab Analytes																						QAL Lab Analytes				
Sampling Date/Time	Ag (ug/L)	Al (ug/L)	As (ug/L)	Ba (ug/L)	Be (ug/L)	Ca (ug/L)	Cd (ug/L)	Co (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	K (ug/L)	Mg (ug/L)	Mn (ug/L)	Na (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Se (ug/L)	Tl (ug/L)	V (ug/L)	Zn (ug/L)	Sulfate (mg/L)	TSS (mg/L)	Lime Demand / Solids Formed (lbs/1,000 gal)		Dissolved Ferrous Iron (mg/L)
01/27/1999 10:57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,800	< 10	11.0	12.6	394
01/27/1999 8:58	1.1	595	11.5	3.8	0.3	2,140	7.8	2.4	0.7	192.0	1,510	0.1	800	620	72.8	493	3.1	60.6	3.5	3.1	4.9	1.4	1,620	19.1	< 10	0.33	0.13	< 10
01/27/1999 8:58	1.0	527	4.5	13.7	0.3	2,140	2.6	2.7	0.7	285.0	459	0.1	832	611	70.2	644	3.1	48.3	3.5	3.1	4.9	1.4	582	18.8	< 10	0.33	0.09	< 10
01/27/1999 9:57	35.8	341,000	7,650	13.4	8.0	7,550	12,900	393	59.2	36,300	3,300,000	0.37	211	38,600	9,430	262,000	491	80.6	145	72.6	4.9	26.1	3,570,000	13,900	60	100.0	243	1,560
2/10/99	0.98	12.8	3.7	1.5	0.3	108	0.3	1.6	0.7	17.2	12.7	0.1	58.8	14.5	2.3	240	3.1	3.6	3.5	3.1	4.9	1.4	28.5	< 1.0	< 10	0.33	0.06	< 10
03/01/1999 7:20	0.7	600.0	10	15.1	0.3	3,330	0.7	7.5	0.7	7.6	12,900	0.1	719	942	1,190	744	5.4	24	4	3.1	4.9	1.4	384	44.7	26	0.67	0.15	14
05/28/1999 12:15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/28/1999 12:25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/28/1999 12:40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/29/1999 7:12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/04/1999	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/18/1999 9:45	58.3	90	4.2	9	0.2	113,000	72.3	71.1	0.7	28.8	666	0.1	3,210	554,000	219,000	2,210	101	1,070	2.1	30.1	59.7	1.5	44,500	3,140	16	5.7	7.18	<10
07/06/1999 16:43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	65.1	11	0.33	0.17	-
07/06/1999 14:58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	997	17	2.34	2.66	-
07/06/1999 14:50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,510	< 10	4.67	5.95	-
07/06/1999 14:27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	514	< 10	1.67	1.86	-
07/27/1999	1.4	24	3.0	0.7	0.4	75	0.5	2.2	1.6	2.5	115	0	106	14.4	11.9	153	2.5	1.7	3.0	2.3	3.3	1.4	35	< 1.0	< 10	0.33	0.003	< 10

Appendix B

Quality Assurance Data Validation Report for Non-CLP Analyses

Data Validation Report

Project/Site Name: Bunker Hill Acid Mine Drainage

Parameters: Sulfate, Total Suspended Solids (TSS), Iron (ferrous), Lime Demand, Solids Formed

Method: Analyses per EPA 375.4(sulfate), EPA 160.2, titration by dichromate (ferrous iron) and project specific methods (lime demand and solids formed).

Laboratory: Columbia Analytical Services, Redding, California

SDG	Station ID	Sample ID	Date Collected	Matrix
RF949	5BK	5BK110698	11/06/98	Water
	5WM	5WM110698	11/06/98	Water
	5WR	5WR110698	11/06/98	Water
RF978	9KT	9KT111398	11/13/98	Water
	29 KT (9KT field dup)	29KT111398	11/13/98	Water
	9LA	9LA111398	11/13/98	Water
	9SO	9SO111398	11/13/98	Water
	9CR	9CR111398	11/13/98	Water
	9BO	9BO111398	11/13/98	Water
	9PU	9PU111398	11/13/98	Water
	9BS	9BS111398	11/13/98	Water
RG026	3HD	3HD112098	11/20/98	Water
RG056	9KT	9KT120198	12/01/98	Water
	9LA	9LA120198	12/01/98	Water
	9FE (9LA field dup)	9FE120198	12/01/98	Water
	9BS	9BS120198	12/01/98	Water
	9SO	9SO120198	12/01/98	Water
	9CR	9CR120198	12/01/98	Water
	9BO	9BO120198	12/01/98	Water
D9900124/RG188	9LA	9LA121698	12/16/98	Water
	9SO	9SO121698	12/16/98	Water
	9CR	9CR121698	12/16/98	Water
	9BO	9BO121698	12/16/98	Water
	9PU	9PU121698	12/16/98	Water
	9BS	9BS121698	12/16/98	Water
	9FE (9BS field dup)	9FE121698	12/16/98	Water

SDG	Station ID	Sample ID	Date Collected	Matrix
D9900145/RG208	9KT	9KT121798	12/17/98	Water
	3HD	3HD121798	12/17/98	Water
	5BK	5BK121798	12/17/98	Water
	5WM	5WM121798	12/17/98	Water
	5WR	5WR121798	12/17/98	Water
D9900250/D0031	9LA	9LA010799	01/07/99	Water
	9SO	9SO010799	01/07/99	Water
	9CR	9CR010799	01/07/99	Water
	9BO	9BO010799	01/07/99	Water
	9PU	9PU010799	01/07/99	Water
	9KT	9KT010799	01/07/99	Water
	9FE (9KT field dup)	9FE010799	01/07/99	Water
	9BS	9BS010799	01/07/99	Water
D9900297/D0079	3HD	3HD011499	01/14/99	Water
	5BK	5BK011499	01/14/99	Water
	5WM	5WM011499	01/14/99	Water
	5WR	5WR011499	01/14/99	Water
D9900369/D0155	1DC	1DC012799	01/27/99	Water
	3UTZ	3UTZ012799	01/27/99	Water
	2BA	2BA012799	01/27/99	Water
	1FE (2BA field dup)	1FE012799	01/27/99	Water
D9900423/D0208	3HD	3HD020599	02/05/99	Water
	5BK	5BK020599	02/05/99	Water
	5WM	5WM020599	02/05/99	Water
	5WR	5WR020599	02/05/99	Water
	5FE (3HD Field dup)	5FE020599	02/05/99	Water
D9900440/D0221	9LA	9LA021099	02/10/99	Water
	9SO	9SO021099	02/10/99	Water
	9CR	9CR021099	02/10/99	Water
	9BO	9BO021099	02/10/99	Water
	9PU	9PU021099	02/10/99	Water
	9KT	9KT021099	02/10/99	Water
	9BS	9FE021099	02/10/99	Water
	9VR	9VR021099	02/10/99	Water
	9TP (Field Blank)	9TP021099	02/10/99	Water
	9SX	9SX021099	02/10/99	Water

SDG	Station ID	Sample ID	Date Collected	Matrix
D9900541/D0322	9LA	9LA022699	02/26/99	Water
	9SO	9SO022699	02/26/99	Water
	9CR	9CR022699	02/26/99	Water
	9BO	9BO022699	02/26/99	Water
	9PU	9PU022699	02/26/99	Water
	9KT	9KT022699	02/26/99	Water
	9BS	9BS022699	02/26/99	Water
	9VR	9VR022699	02/26/99	Water
	9SX	9SX022699	02/26/99	Water
	9FE (9KT field dup)	9FE022699	02/26/99	Water
D9900543/D0328	7LD	7VD030199	03/01/99	Water
	3HD	3HD030199	03/01/99	Water
	5BK	5BK030199	03/01/99	Water
	5WM	5WM030199	03/01/99	Water
	5WR	5WR030199	03/01/99	Water
D9900654/D0429	11VD	11VD031999	03/19/99	Water
D9900720/D0493	3HD	3HD033199	03/31/99	Water
	5BK	5BK033199	03/31/99	Water
	5WM	5WM033199	03/31/99	Water
	5WR	5WR033199	03/31/99	Water
	5FE (5WM Field dup)	5FE033199	03/31/99	Water
D9900734/D0509	9LA	9LA040299	04/02/99	Water
	9SO	9SO040299	04/02/99	Water
	9CR	9CR040299	04/02/99	Water
	9BO	9BO040299	04/02/99	Water
	9PU	9PU040299	04/02/99	Water
	9KT	9KT040299	04/02/99	Water
	9BS	9BS040299	04/02/99	Water
	9VR	9VR040299	04/02/99	Water
	9SX	9SX040299	04/02/99	Water
D9900776/D0547	3HD	3HD041399	04/13/99	Water
	5BK	5BK041399	04/13/99	Water
	5WM	5WM041399	04/13/99	Water
	5WR	5WR041399	04/13/99	Water
	5FE (5WM Field dup)	5FE041399	04/13/99	Water

SDG	Station ID	Sample ID	Date Collected	Matrix
D9900779/D0554	9LA	9LA041499	04/14/99	Water
	9SO	9SO041499	04/14/99	Water
	9CR	9CR041499	04/14/99	Water
	9BO	9BO041499	04/14/99	Water
	9PU	9PU041499	04/14/99	Water
	9KT	9KT041499	04/14/99	Water
	9BS	9BS041499	04/14/99	Water
	9VR	9VR041499	04/14/99	Water
	9SX	9SX041499	04/14/99	Water
D9900876/D0649	3HD	3HD042999	04/29/99	Water
	5BK	5BK042999	04/29/99	Water
	5WM	5WM042999	04/29/99	Water
	5WR	5WR042999	04/29/99	Water
	5FE (5WM Field dup)	5FE042999	04/29/99	Water
D9900906/D0675	9LA	9LA050599	05/05/99	Water
	9SO	9SO050599	05/05/99	Water
	9CR	9CR050599	05/05/99	Water
	9BO	9BO050599	05/05/99	Water
	9PU	9PU050599	05/05/99	Water
	9KT	9KT050599	05/05/99	Water
	9BS	9BS050599	05/05/99	Water
	9VR	9VR050599	05/05/99	Water
	9SX	9SX050599	05/05/99	Water
D9900978/D0743	3HD	3HD051999	05/19/99	Water
	5BK	5BK051999	05/19/99	Water
	5WM	5WM051999	05/19/99	Water
	5WR	5WR051999	05/19/99	Water
	5FE (3HD Field dup)	5FE051999	05/19/99	Water
D9900992/D0757	9LA	9LA052199	05/21/99	Water
	9SO	9SO052199	05/21/99	Water
	9CR	9CR052199	05/21/99	Water
	9BO	9BO052199	05/21/99	Water
	9KT	9KT052199	05/21/99	Water
	9BS	9BS052199	05/21/99	Water
	9VR	9VR052199	05/21/99	Water
	9SX	9SX052199	05/21/99	Water
D9901012/D0777	3HD	3HD052799	05/27/99	Water
	5BK	5BK052799	05/27/99	Water
	5WM	5WM052799	05/27/99	Water
	5WR	5WR052799	05/27/99	Water
	5FE (3HD Field dup)	5FE052799	05/27/99	Water

SDG	Station ID	Sample ID	Date Collected	Matrix
D9901021/D0784	9LA	9LA052899	05/28/99	Water
	9SO	9SO052899	05/28/99	Water
	9CR	9CR052899	05/28/99	Water
	9BO	9BO052899	05/28/99	Water
	9KT	9KT052899	05/28/99	Water
	9BS	9BS052899	05/28/99	Water
	9VR	9VR052899	05/28/99	Water
	9SX	9SX052899	05/28/99	Water
D9901046/D0808	9KT	9KT060399	06/03/99	Water
D9901090/D0844	3HD	3HD060999	06/09/99	Water
	5BK	5BK060999	06/09/99	Water
	5WM	5WM060999	06/09/99	Water
	5WR	5WR060999	06/09/99	Water
	5FE (5WR Field dup)	5FE060999	06/09/99	Water
D9901153/D0900	9LA	9LA061899	06/18/99	Water
	9SO	9SO061899	06/18/99	Water
	9CR	9CR061899	06/18/99	Water
	9BO	9BO061899	06/18/99	Water
	9KT	9KT061899	06/18/99	Water
	9BS	9BS061899	06/18/99	Water
	9VR	9VR061899	06/18/99	Water
	9SX	9SX061899	06/18/99	Water
	9S2	9SC061899	06/18/99	Water
	9PU	9PU061899	06/18/99	Water
	10PU	10PU061899	06/18/99	Water
D9901215/D0957	9LA	9LA070299	07/02/99	Water
	9KT	9KT070299	07/02/99	Water
	9BS	9BS070299	07/02/99	Water
	9FE (9KT field dup)	9FE070299	07/02/99	Water
	9PU	9PU070299	07/02/99	Water
D9901232/D0974	2SU	HS1070699	07/06/99	Water
	6DP	HS2070699	07/09/99	Water
	6HS	HS3070699	07/06/99	Water
	6PD	HS4070699	07/06/99	Water
D9901374/D1116	3HD	3HD072799	07/27/99	Water
	5BK	5BK072799	07/27/99	Water
	5WM	5WM072799	07/27/99	Water
	5WR	5WR072799	07/27/99	Water
	5FE (3HD Field dup)	5FE072799	07/27/99	Water
	5TP (Blank)	5TP072799	07/27/99	Water

SDG	Station ID	Sample ID	Date Collected	Matrix
D9901549/D1280	3HD	3HD082699	08/26/99	Water
	5BK	5BK082699	08/26/99	Water
	5WM	5WM082699	08/26/99	Water
	5WR	5WR082699	08/26/99	Water
	5FE (3HD Field dup)	5FE082699	08/26/99	Water
D9901633/D1366	9LA	9LA091099	09/10/99	Water
	9SO	9SO091099	09/10/99	Water
	9CR	9CR091099	09/10/99	Water
	9BO	9BO091099	09/10/99	Water
	9KT	9KT091099	09/10/99	Water
	9BS	9BS091099	09/10/99	Water
	9VR	9VR091099	09/10/99	Water
	9SX	9SX091099	09/10/99	Water
	9PU	9PU091099	09/10/99	Water

Introduction/Summary

This data review report covers the sample delivery group and associated samples listed on the cover sheet. The analyses were per EPA 375.4(sulfate), EPA 160.2(total suspended solids,TSS),titration with dichromate (ferrous iron) and project methodology (lime demand and solids formed) as detailed in the project quality assurance plan (QAPP). The quality assurance and quality control procedures (QA/QC) were per the project QAPP and the individual method requirements.

This review is based on the methods and project QAPP. The sections detail noted deviations if any. Tables summarizing all data qualification flags are provided at the end of this report. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from specified project protocols or is of a technical advisory nature per sample matrix or method limitation.

All data were found to be acceptable per the above specifications, a summary is provided in tables at the end of this report.

I. Technical Holding Times

Samples were analyzed within the holding times listed below:

Method	Holding Time
Sulfate (USEPA 375.4)	28 days
TSS (USEPA 160.2)	7 days

II. Calibration

a. Initial Calibration

1. Sulfate

An initial minimum four-point calibration was carried out as required at the beginning of each analysis period.

The correlation coefficient was greater than 0.995.

An initial calibration verification solution was analyzed prior to analyses.

All percent recoveries were within 90 - 110%.

2. Total Suspended Solids

Not applicable.

3. Iron, Ferrous

Not applicable as it is a titration method.

4. Lime Demand

Not applicable.

5. Solids Formed

Not applicable.

b. Calibration Verification

1. Sulfate

Calibration verification was carried out daily and after every ten samples.

All percent recoveries were within 90 - 110% as required.

2. Total Suspended Solids

Not applicable.

3. Iron, Ferrous

Not applicable.

4. Lime Demand

Not applicable.

5. Solids Formed

Not applicable.

III. Blanks

Method blanks were prepared and analyzed as required for each analysis at the frequency requirement of one per group of twenty or fewer samples. Target analytes were not detected in the method blanks.

IV. Accuracy and Precision Data

a. Surrogate Recovery

Not applicable for these methods.

b. Laboratory Control Sample

Laboratory control samples were analyzed for sulfate, total suspended solids, and ferrous iron as required.

All percent recoveries (%R) were within 75-125%.

c. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) analyses were performed for sulfate and ferrous iron.

All percent recoveries (%R) were within 75-125% as required.

d. Duplicates

Duplicate analyses were performed for all parameters at the required frequency of one per group of twenty or fewer samples.

Relative percent differences (%RPD) were within the ±25% criteria.

e. Standard Reference Materials Analysis

Standard reference material analyses were performed for sulfate.

All percent recoveries (%R) were within 85-115% as required.

V. Sample Result Verification

Laboratory algorithms were verified to all be correct.

VI. Overall Assessment

All data were found to meet project criteria and as noted in the following summary tables no data have been qualified.

Bunker Hill Acid Mine Drainage Data Qualification Summary

No data have been qualified for this group of samples.

Bunker Hill Acid Mine Drainage Blank Data Qualification Summary

No data have been qualified for this group of samples.

Appendix C

Kellogg Tunnel Flow Variations Memorandum by Bill Hudson

Memorandum

To: Jim Stefanoff, CH2M HILL, Spokane

CC:

From: Bill Hudson, CH2M HILL, Kellogg

Date: 01/28/00

Re: KT Flow Variables

KT flows can be influenced by a number of variables, these can be broken down into those outside of the mine and those inside of the mine. Variables outside of the mine include:

- The degree to which the flume is cleaned and the frequency.
- How often the bubble meter is adjusted by the CTP crew, currently it needs adjustment greater then 50% of the time I check on the flow. The probe also requires periodic cleaning although this does not seem to be on any set schedule.
- Past blockages in the mine water line or excessive flows have also backed up the water in the flume and resulted in excessive flow readings.

The trash rack downstream of the flume also requires cleaning, and if now this will also result in water backing up in the flume, the trash rack in the catch basin in front of the mine office will also give the same results if not kept clean.

Variables within the mine, which can influence flow reading at the KT, are as follows:

- Flyte pumps at 9BS can currently deliver West side 9 Level waters to the KT portal, if these pumps are shut off, an immediate drop in flows will result, and result in at least an hour and a half delay in the flows picking up again due to the length of the x-cut from the pumps to the portal.
- 9 Level Newgard pumps are used on a seasonal basis and are cyclic
- No. 1 Shaft 10 Level pumps are in use and operate off of a float setup
- No. 2 Shaft 11 Level pump flows will fluctuate due to debris build up on the inlet screens, and are periodically turned off for maintenance or repairs.
- Flows upstream of 9LA can vary in the spring due to yellowboy dams breaching and releasing pooled water.

Appendix D

Past and Present Flow and Zinc Loading Comparison Figures and Memorandum by John Riley

Preliminary Discussion of Bunker Hill Mine Flow and Zinc Loading Graphs

PREPARED FOR: Jim Stefanoff/CH2M HILL

PREPARED BY: John A. Riley/Pyrite Hydrochem

DATE: January 4, 2000

Introduction

This technical memorandum presents a preliminary discussion of flow and zinc loading during water year 1999 in comparison to historical data from water years 1983 through 1988. Not all locations were monitored for the entire historical period. The purpose of this discussion is to present some of the characteristics of and relations among locations. No attempt is made to be all inclusive. Rather the intent is to engender comments and suggestions for additional interpretation that may be possible. A better understanding of recharge mechanisms, flushing dynamics, flow path characteristics, and system storage could be developed based on these interpretations. This would lead to a more defensible understanding of the relative merits of various remediation and management options.

Flows

3 Level

The flow and metal load at 3 HD (Figure D-1) represents recharge from the South Fork of Milo Creek. It is not a particularly good indicator of the overall flux of water and metal through the Homestake (and Utz) workings. Ponds fill and flows increase in other parts of the Homestake and Utz when outside temperatures are below freezing. This suggests that heat from pyrite oxidation within the workings is sufficient to melt the overlying snow.

Nevertheless, the shape of the hydrograph and timing of peak flow at 3HD in the Homestake are very similar to 5WR on 5 level.

5 Level

The 1999 flow at 5WR (in the West Reed drift) (Figure D-2) represents discharge from acid producing areas, including the underground greenhouse, and scrams and ore chutes related to block caving of the Flood Stanly ore body. As is typical of discharge from the Flood Stanly, the amount of discharge is small, but the metal load is substantial.

The discharge at 5WR in water year 1999 was very similar to the historic record. Timing and magnitude of peak flows are within the distribution of previous years, except that water year 1985 has a larger peak flow than any of the other years. The recessional limbs appear similar to one another.

The timing of peak flows, and the general characteristics of the recessional limbs in water year 1999 at 3HD and 5 WR are very similar to each other. This is not the case in water year 1987. It may be possible to infer characteristics of recharge, discharge and storage by analyzing these and other contrasts in more depth.

The 1999 flow at 5BK (Figure D-3) is very similar to the historic record. Base flow, peak timing and peak duration are well within the distribution of previous data. The record from water year 1983 and early water year 1984 is not comparable to the remaining years. Discharge from the Reed tunnel pump-back system flowed through the flume until February 1984. At that time the pump-back discharge was diverted, and quantified separately.

The 1999 flow at 5WM (Figure D-4) is similar, but slightly lower than the historical record. Base flow is almost identical to previous years. Peak flows are lower than most previous years, and the shape of the recessional limb appears slightly different. This may be caused by a change in flow path in the Asher Drift. During the late 1980's, mining was taking place near the end of the Asher. A ramp was constructed from the Asher/Russell sub-level down to the Reed level. Water that previously drained along the Asher, through 5WM, now drains down the ramp and (probably) directly into the Motor Vein. The anomalously low flows in water year 1988 may have been influenced by mining activities. That was after my time; Bretherton may discuss that in his thesis.

Overall, 1999 flows on 3 and 5 levels are very similar to the historic record. This suggests that recharge along the main fork of Milo Creek has not changed substantially.

9 Level

The 1999 flow at 9BO (Figure D-5) is very similar to the historical record. The peak occurs somewhat earlier than it did in water year 1988, but the timing was similar to water year 1984.

The 1999 flow from the Flood Stanly ore body changed dramatically as compared to the historical record. The monitoring locations that demonstrate this are 9CR, 9SX, 9SO, and consequently 9LA. Base flow at these locations is almost identical to the historic record.

Peak flows in water year 1999 are much higher than the historical record—having increased by factors of 2 to 12. However the timing of the peaks and onset of increasing flows are well within the distribution of previous data. Peak flow increases at the four locations are as follows:

- 9CR—Increase of 130 percent (Figure D-6)
- 9SO—Increase of 200 percent (Figure D-7)
- 9SX—Increase of 1,200 percent (Figure D-8)
- 9LA—Increase of 100 percent (Figure D-9)

The peak flows at 9SO and 9CR occur at the same time. Peak flow at 9SX occurs one monitoring event later. This suggests that the flow path to 9SX is slightly more circuitous or contains more storage than the flow paths to 9SO and 9CR.

The duration of peak flows is short, suggesting a direct recharge flow path, with very limited storage. The increase in flow at these locations began only 2 or 3 days after a significant warming in surface temperatures. This reinforces the idea that the flow path is short and direct.

The timing of these increases and peaks coincides with timing of high snowmelt, and observed infiltration near the hanging wall of the Guy Caving Area. This is a strong indication that the majority of the increase in flow from the Flood Stanly is recharged from West Milo. This increased peak flow does not appear anywhere in the accessible portions of 5 level.

The 1999 flow at 9BS (Figure D-10) has not changed as compared with historical. The peak flow occurs approximately three months earlier than the peaks from the Flood Stanly, indicating a completely different recharge source.

Zinc Loading

3 Level

Zinc loading from 3HD (Figure D-11) is very low. However, water quality degrades rapidly along this flow path. Zinc loading in water year 1999 is similar to the historic record.

5 Level

Zinc loading at 5WR (Figure D-12) during water year 1999 is within the variability of the historic record. 5WR exhibits higher variability from year to year than most other locations do. 5WR supplies approximately 70 percent of load to 5BK during the spring flushing event; all other tributary sources supply the remaining 30 percent.

The timing of peak load and shape of zinc loading curve at 3HD and 5WR are similar, especially in early response. The magnitude of the daily loading is substantially different. Nevertheless, the timing of the initial flushing at each location is identical. The first peak occurs in mid March at both locations. A second peak occurs in mid April. That peak in the Homestake is less than the preceding peak. The opposite is true at the West Reed, suggesting that more reaction products are available in the West Reed flow path than in the south portions of the Homestake.

Peak zinc loading at 5BK (Figure D-13) in water year 1999 has increased by 100 to 150 pounds per day as compared to the historic record. This may be because of ramp and stope development from the Asher drift that took place in the late 1980s. Zinc loading at low flow is similar to the historic record.

Peak zinc loading at 5WM (Figure D-14) in water year 1999 has decreased by approximately 50 pounds per day as compared to the historic record. This is probably a result of water diversions in the Asher Drift. Some of the acidic water that historically flowed down the Asher has been diverted down the new ramp toward the Reed. The water discharges toward the Motor Vein, but it was impossible to follow it because of ground conditions.

9 Level

Zinc loading at 9 BO (Figure D-15) in water year 1999 is similar to the historical record. 9BO is insignificant as a source of zinc loading. The peaks never exceed 6 pounds per day.

Zinc loading at 9CR (Figure D-16) in water year 1999 is similar to the historic record, both during peak and base flows. The loading peaks in water year 1984 and 1999 are very similar to each other. On the other hand, the timing of loading maxima at 9CR do not coincide with any maxima at 5WR. This suggests that different recharge locations and/or mechanisms are influencing these two locations.

The 1999 zinc loading from the Flood Stanly ore body changed as compared to the historical record. However the increase in loading is not as great as the increase in flow. The monitoring locations that demonstrate this are 9SX, 9SO, and consequently 9LA. Zinc loading during base flow at these locations is almost identical to the historic record.

Peak zinc loads in water year 1999 are somewhat higher than the historical record—having increased by factors of zero to 3.5. However the timing of the peaks and onset of increasing loads are well within the distribution of previous data. Peak loading increases at the four locations are as follows:

- 9CR—No change (Figure D-16)
- 9SO—Increase of 120 percent (Figure D-17)
- 9SX—Increase of 350 percent (Figure D-18) and
- 9LA—Increase of 220 percent (Figure D-19)

Peak zinc loading at 9CR, 9SO and 9SX occur at the same time. This is unlike the flow peaks which occurred earlier at 9CR and 9SO than 9SX. The peak loading occurred on the rising limb of the hydrograph, and the duration of flushing tributary to 9SX was very short during 1999. This suggests that the water was able to contact only a limited amount of the existing reaction products, or that a limited amount of reaction products had accumulated.

The timing of the increases and peaks in loading coincides with timing of high snow melt, and probable recharge via the hanging wall of the Guy Caving area.

Zinc loading at 9BS (Figure D-20) has not changed as compared with the historical record.

Conclusions and Recommendations

Flow

- The timing of flow peaks are the same at 3HD and 5 WR.

- Flow peaks and base flow at 5BK and 5WM are very similar to the historic record. This suggests that recharge quantities along the main stem of Milo Creek have not changed substantially in recent years.

- Conditions at 9BO are similar to the historic record, indicating that discharge from the drill hole on 7 level has not changed.

- Flow through and from the Flood Stanly ore body has changed substantially since the mid 1980's. Peak flows have increased by a factor between 2 and 12. Base flow conditions are very similar to the historical record. The rising and falling limbs of the hydrograph are steep, and the duration of peak flow is short. These characteristics suggest a direct flow path.

- The timing of increased flows through the Flood Stanly coincides with the onset of high elevation snowmelt, and recharge via the West Fork of Milo Creek.
- Flow at 9BS is very similar to the historical record, indicating that recharge from Deadwood has not changed substantially.

Zinc Loading

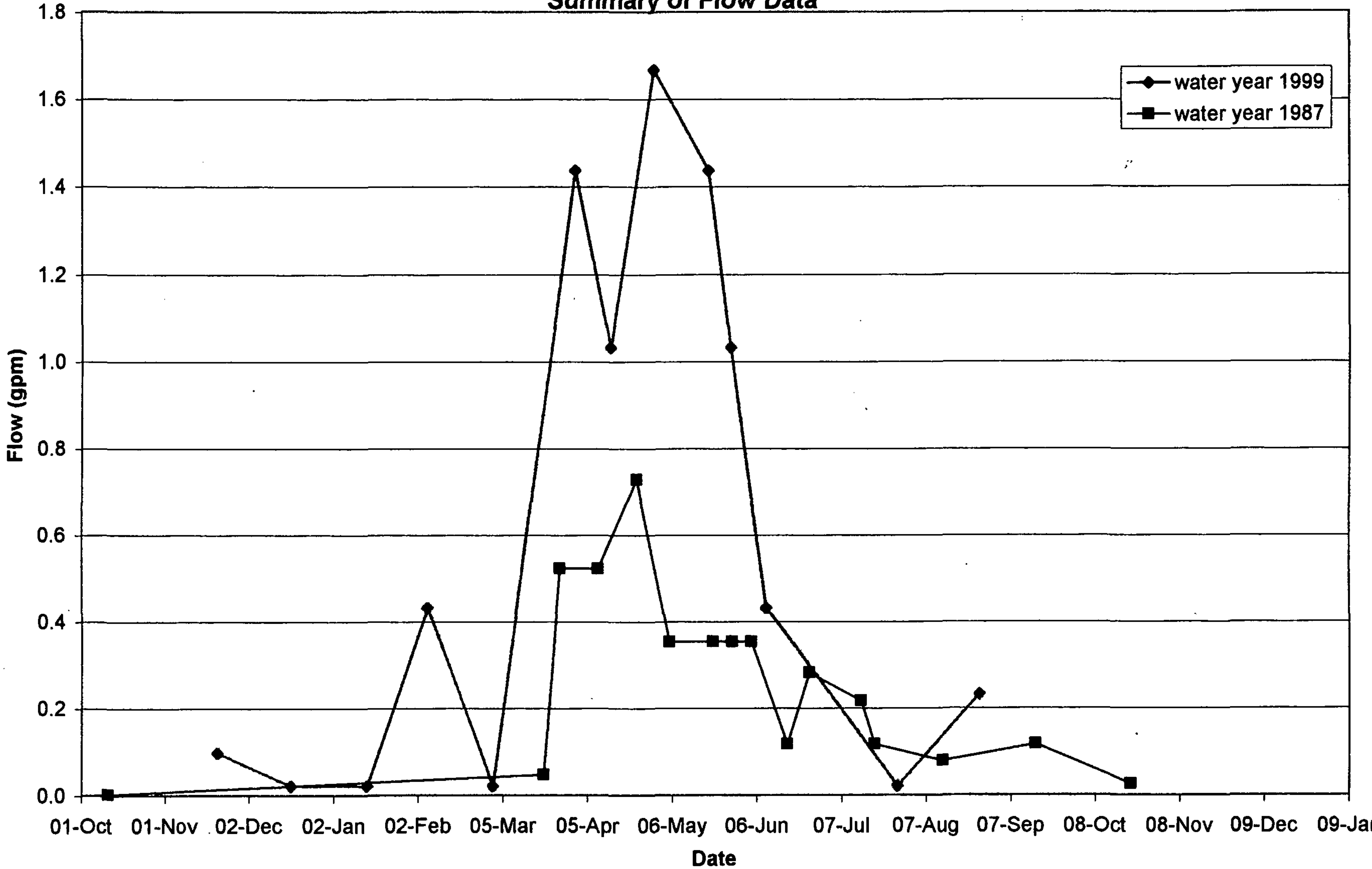
- The timing of zinc loading peaks are the same at 3HD and 5 WR.
- Loading peaks and base flow at 5BK and 5WM are similar to the historic record. However, loading at 5BK has increased slightly, and decreased slightly at 5WM,
- Conditions at 9BO are similar to the historic record, indicating that loading from the drill hole on 7 level has not changed.
- Loading through and from the Flood Stanly ore body has changed somewhat since the mid 1980's. Peak loads have increased by a factor between zero and 3.5. This is substantially less than the observed increase in flow. Load during base flow conditions are very similar to the historical record. The rising and falling limbs of the loading are steep, and the duration of flushing is short. These characteristics suggest a quick flushing of easily accessible reaction products and/or a limited accumulation of reaction products.
- The loading maxima at 9CR and 5WR occur at different times, suggesting a different recharge source for each.
- The timing of increased flows through the Flood Stanly coincides with the onset of high elevation snowmelt, and recharge via the West Fork of Milo Creek.
- Flow at 9BS is very similar to the historical record.

This preliminary interpretation of the flow and zinc loading dynamics has revealed insight into plausible recharge mechanisms and pathways, contrasts among the dynamics of locations, and comparisons of historical and current conditions. This effort has barely begun to investigate the wealth of information that is contained in the record. Other expertise and interpretation techniques could amplify our understanding of the system and/or test hypotheses regarding the mine hydrology, recharge mechanisms, and flushing dynamics.

I recommend that an interdisciplinary team brainstorm additional interpretation avenues to explore. It seems logical to do this in conjunction with a scheduled meeting when we would be together anyway. The focus of the additional interpretation effort should be increasing our understanding of those portions of the flow system and dynamics that would aid in evaluation of surface and in-mine reclamation options that are under consideration.

Figure D1 Through D20

Figure D-1
3HD
Summary of Flow Data



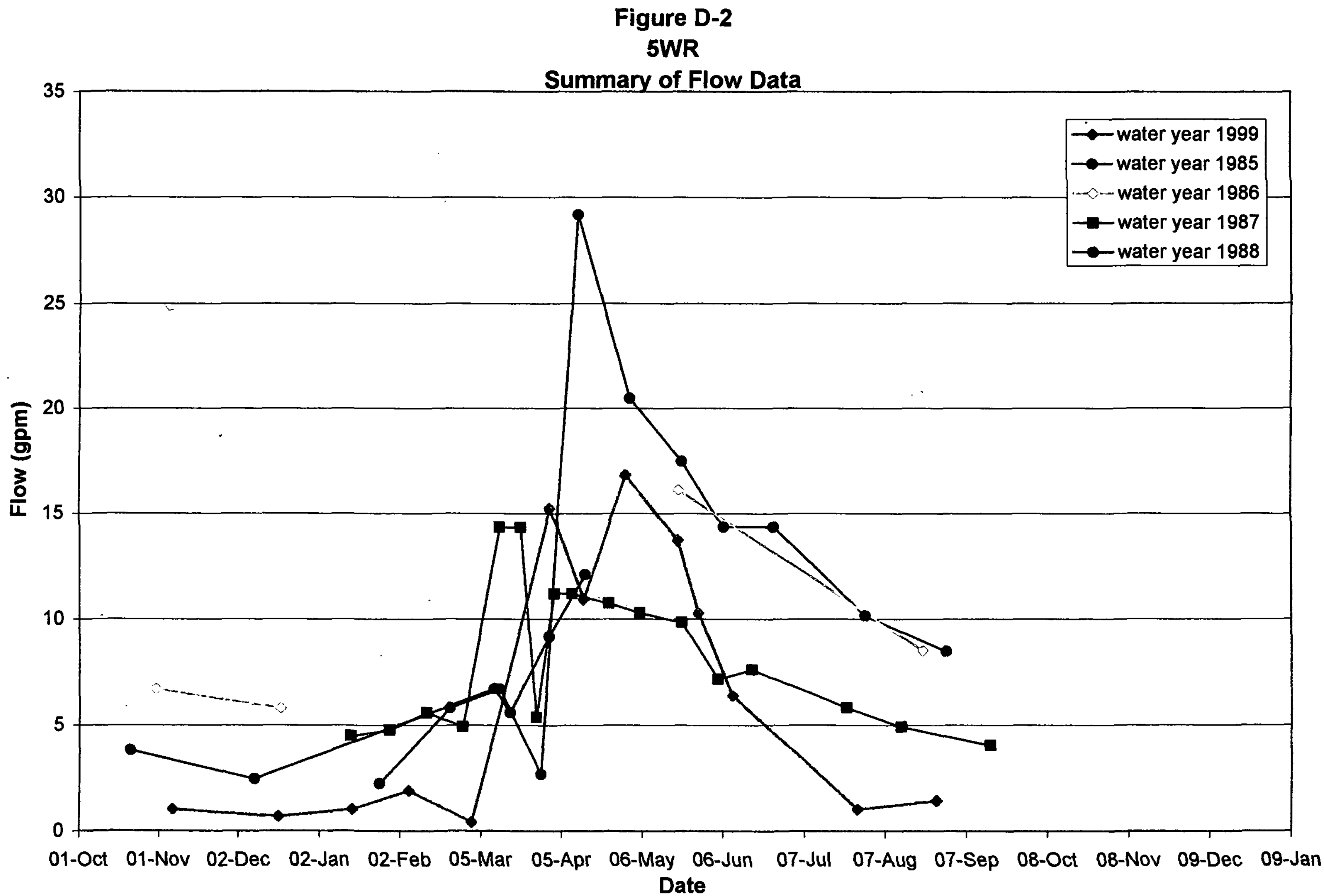
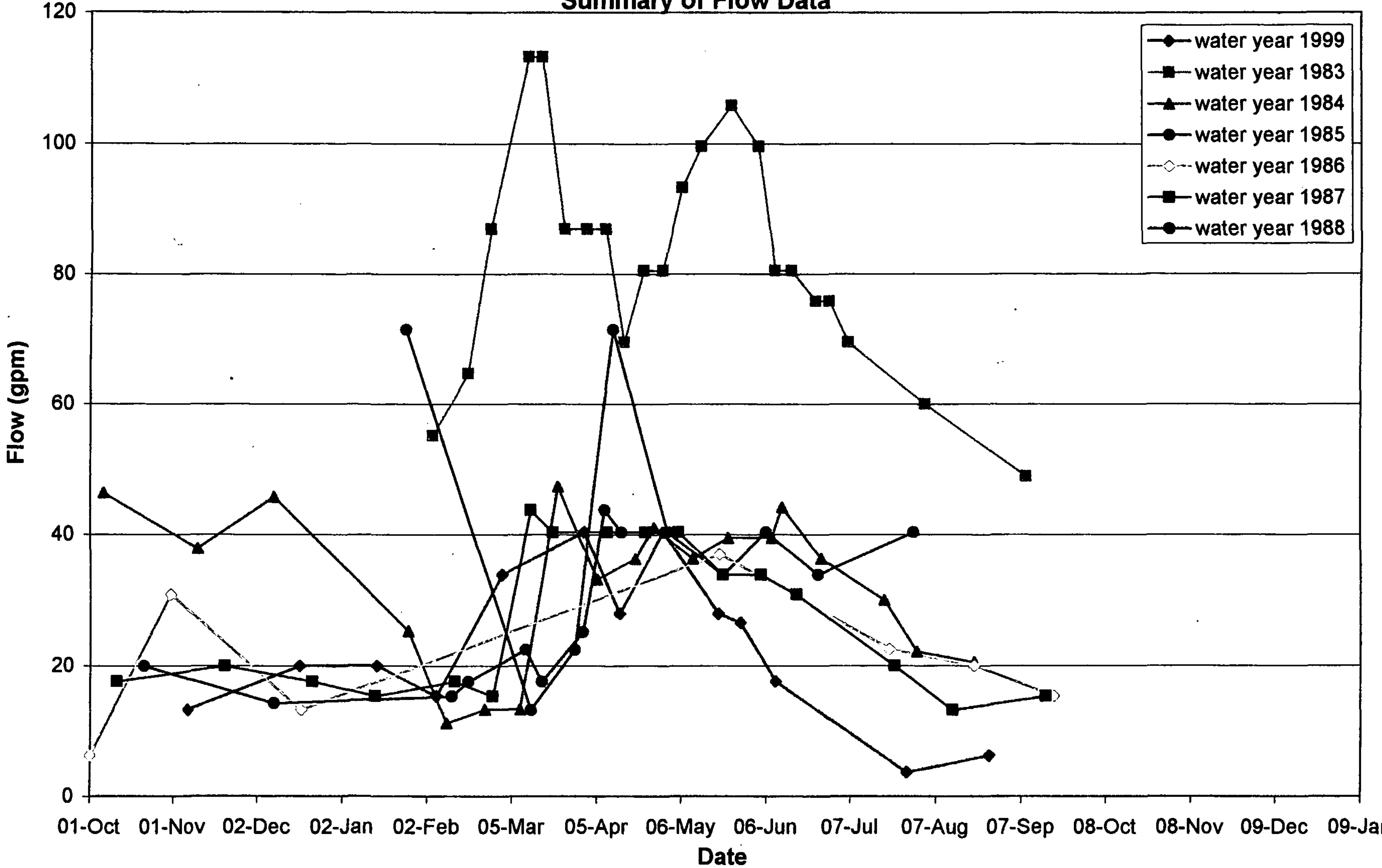


Figure D-2
5WR
Summary of Flow Data
Flow (gpm)
Date
water year 1999
water year 1985
water year 1986
water year 1987
water year 1988
0
5
10
15
20
25
30
35
01-Oct
01-Nov
02-Dec
02-Jan
02-Feb
05-Mar
05-Apr
06-May
06-Jun
07-Jul
07-Aug
07-Sep
08-Oct
08-Nov
09-Dec
09-Jan

Figure D-3
5BK
Summary of Flow Data



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\1999 Final Summary\Flowinc Loading Summary- Past vs. Present.xls

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Figure D-4
5WM
Summary of Flow Data

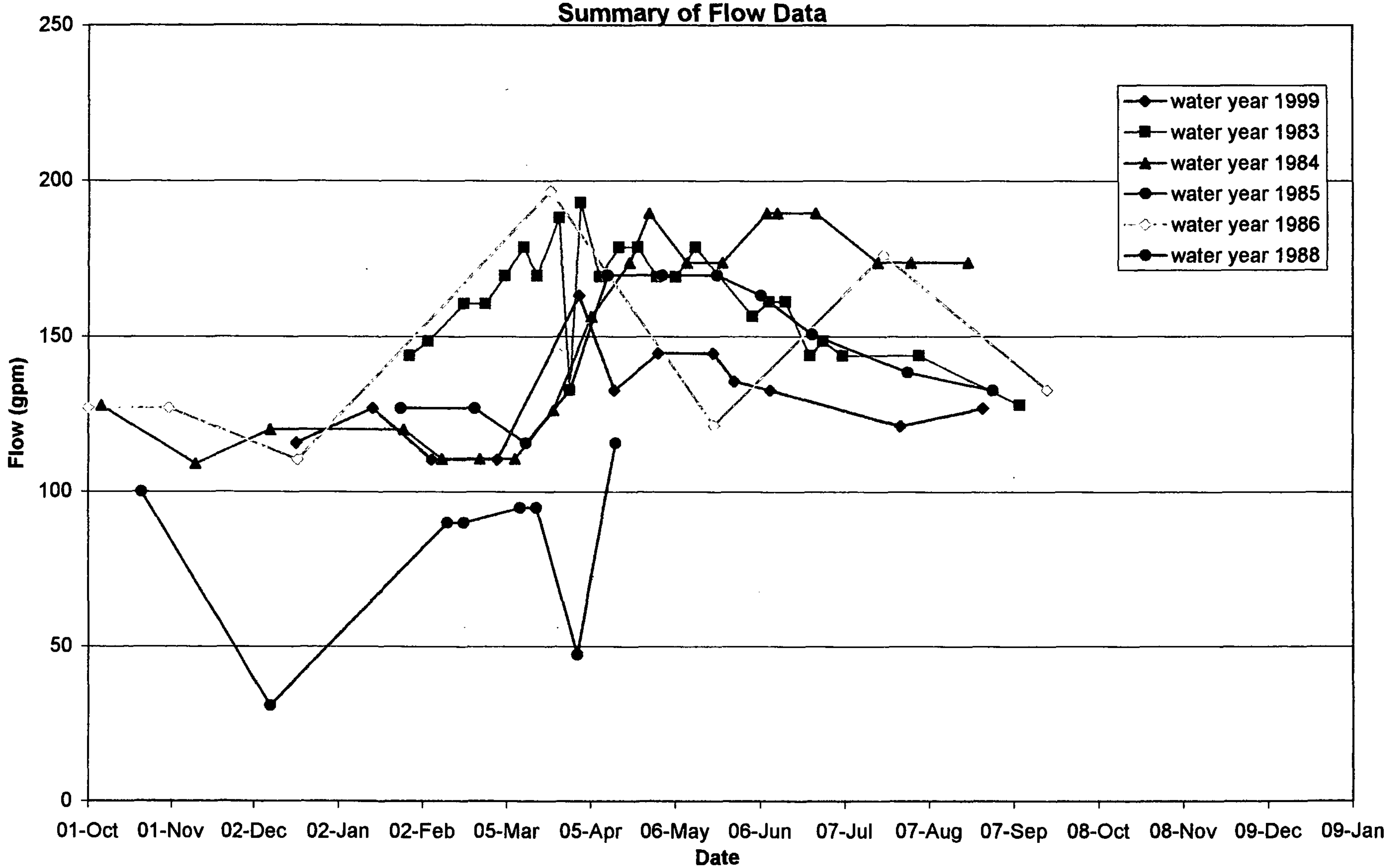
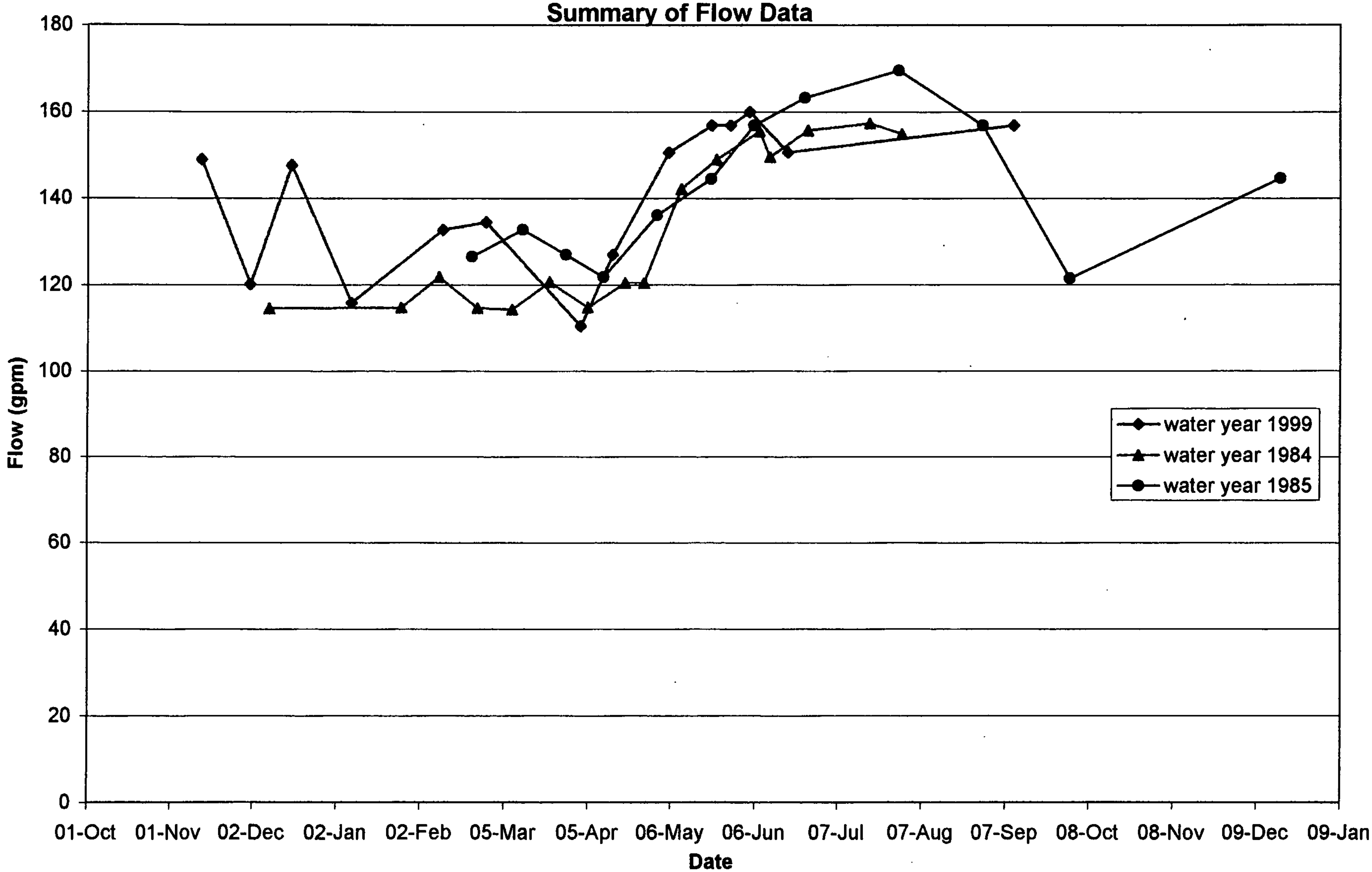


Figure D-5
9BO
Summary of Flow Data



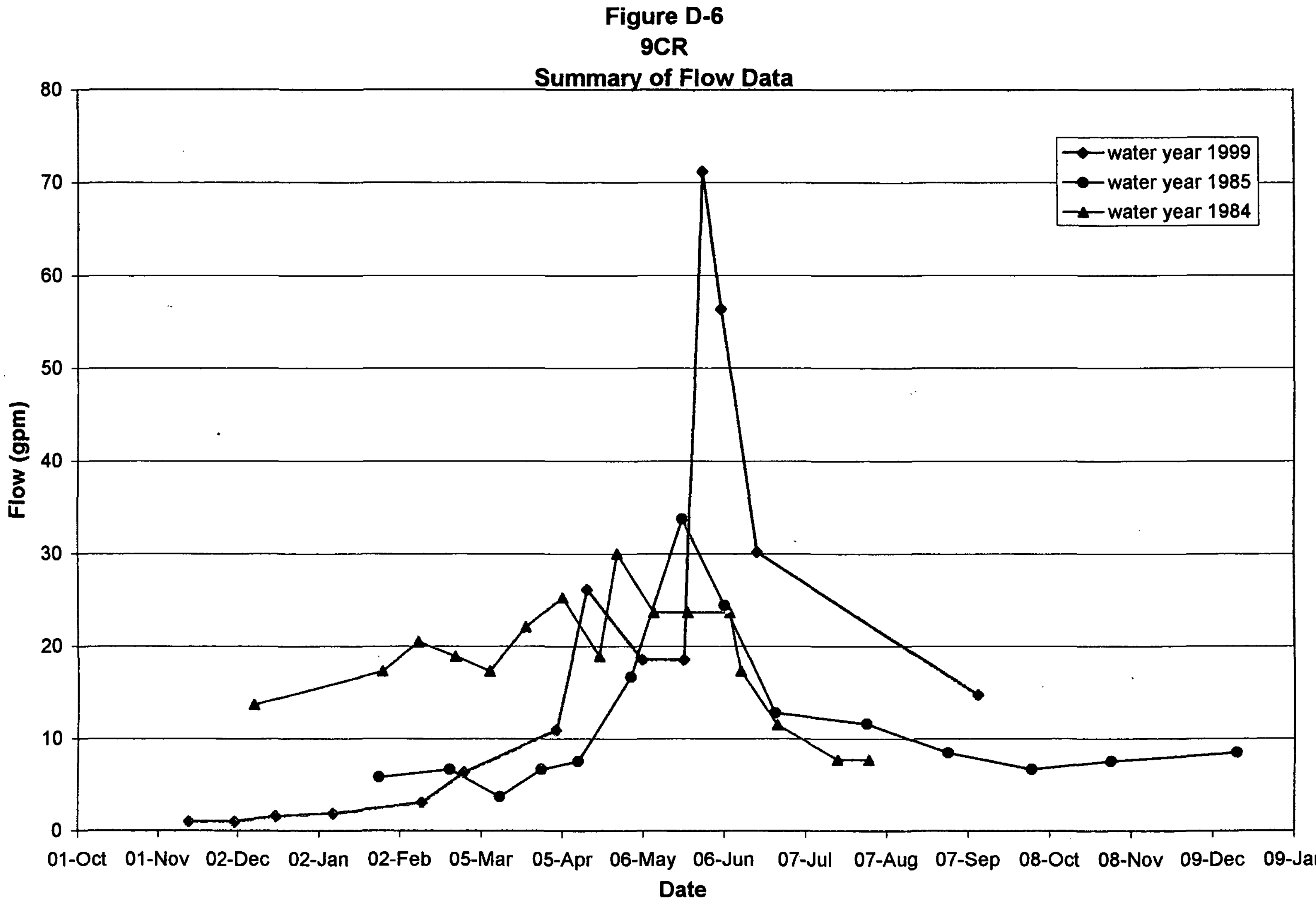
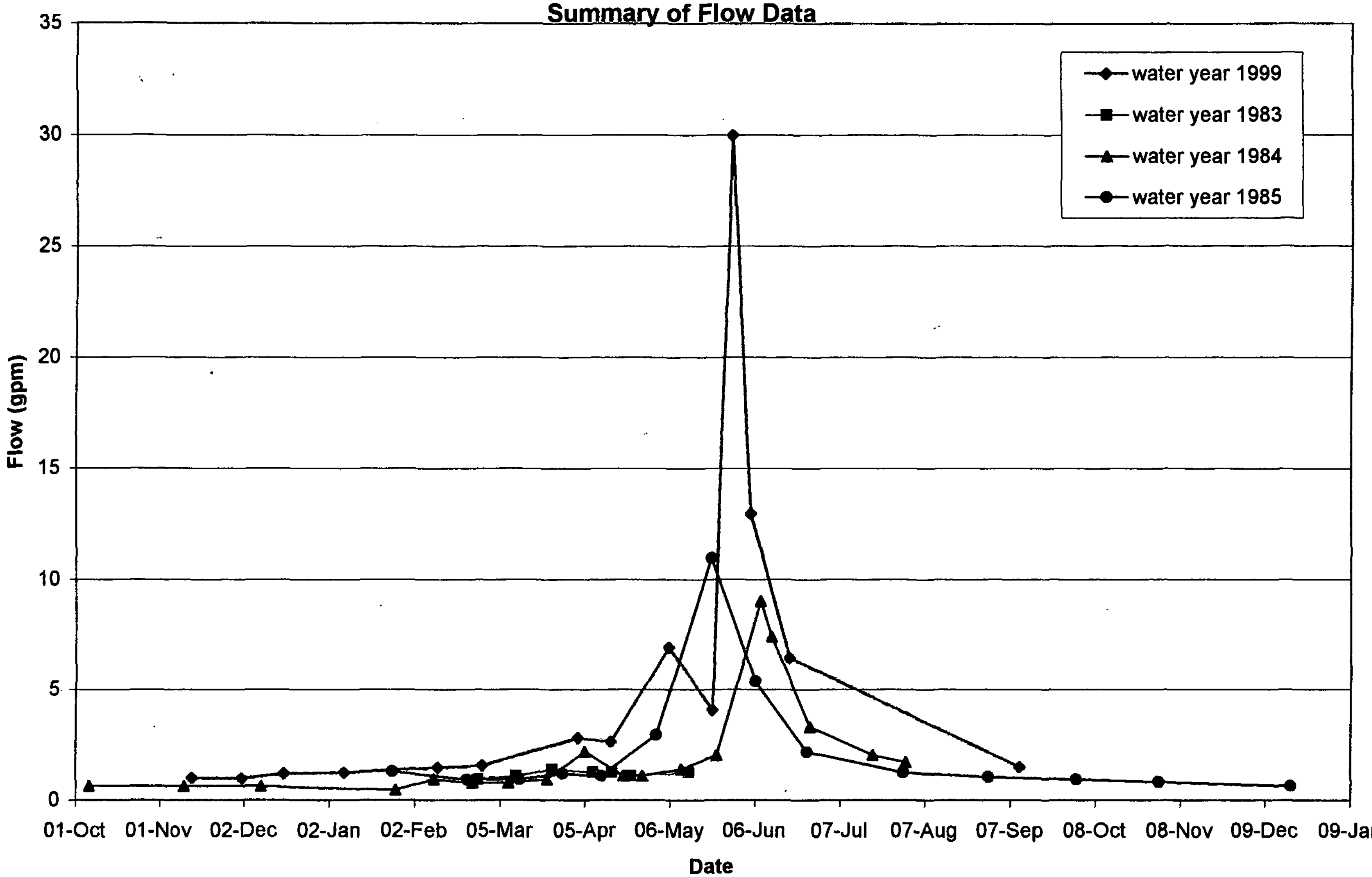


Figure D-6
9CR
Summary of Flow Data
water year 1999
water year 1985
water year 1984
Flow (gpm)
0
10
20
30
40
50
60
70
80
01-Oct
01-Nov
02-Dec
02-Jan
02-Feb
05-Mar
05-Apr
06-May
06-Jun
07-Jul
07-Aug
07-Sep
08-Oct
08-Nov
09-Dec
09-Jan
Date

Figure D-7
9SO
Summary of Flow Data



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6.5.4
147887

Figure D-8
9SX
Summary of Flow Data

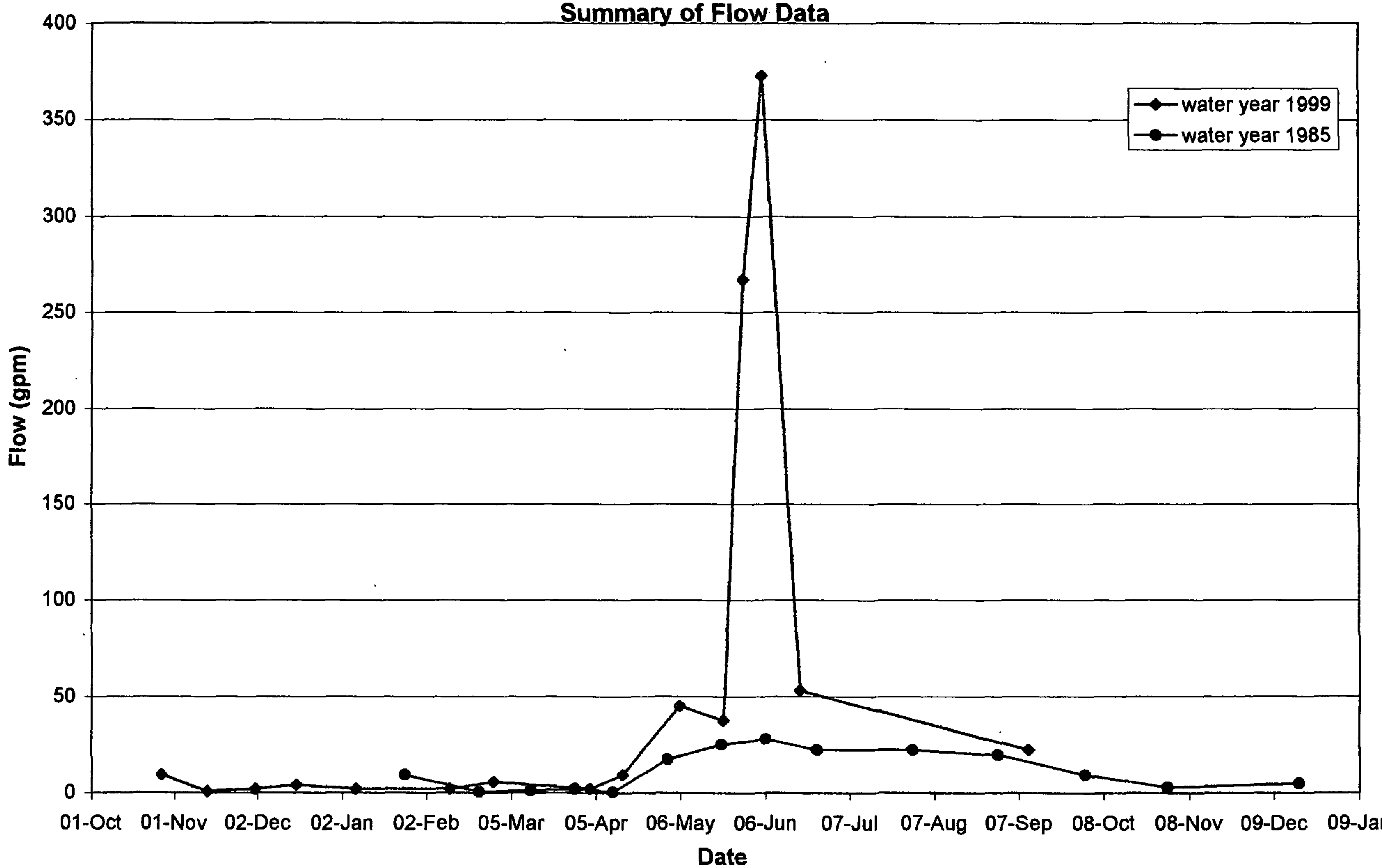

Figure D-9
9LA
Summary of Flow Data

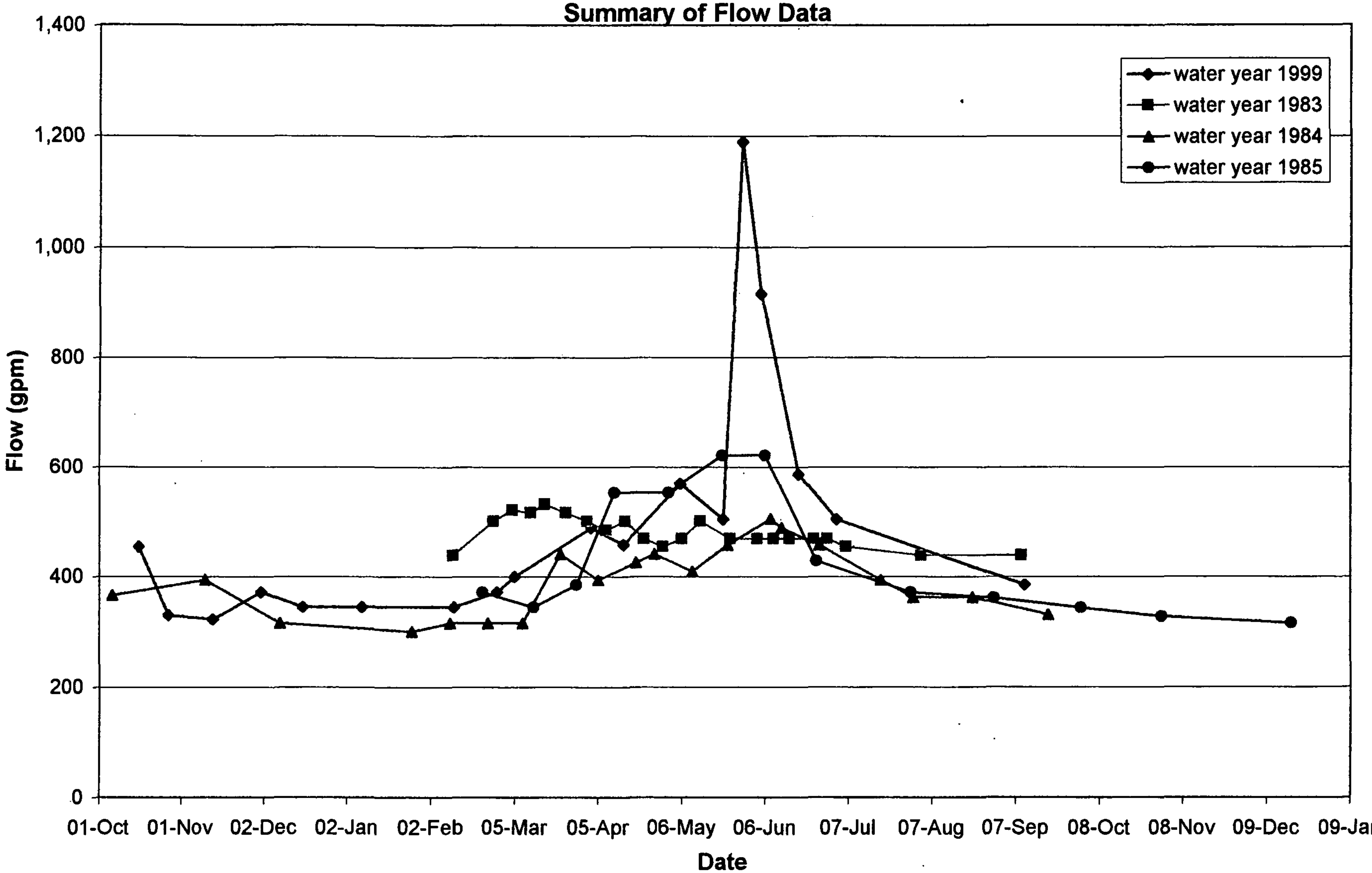

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Figure D-10
9BS
Summary of Flow Data

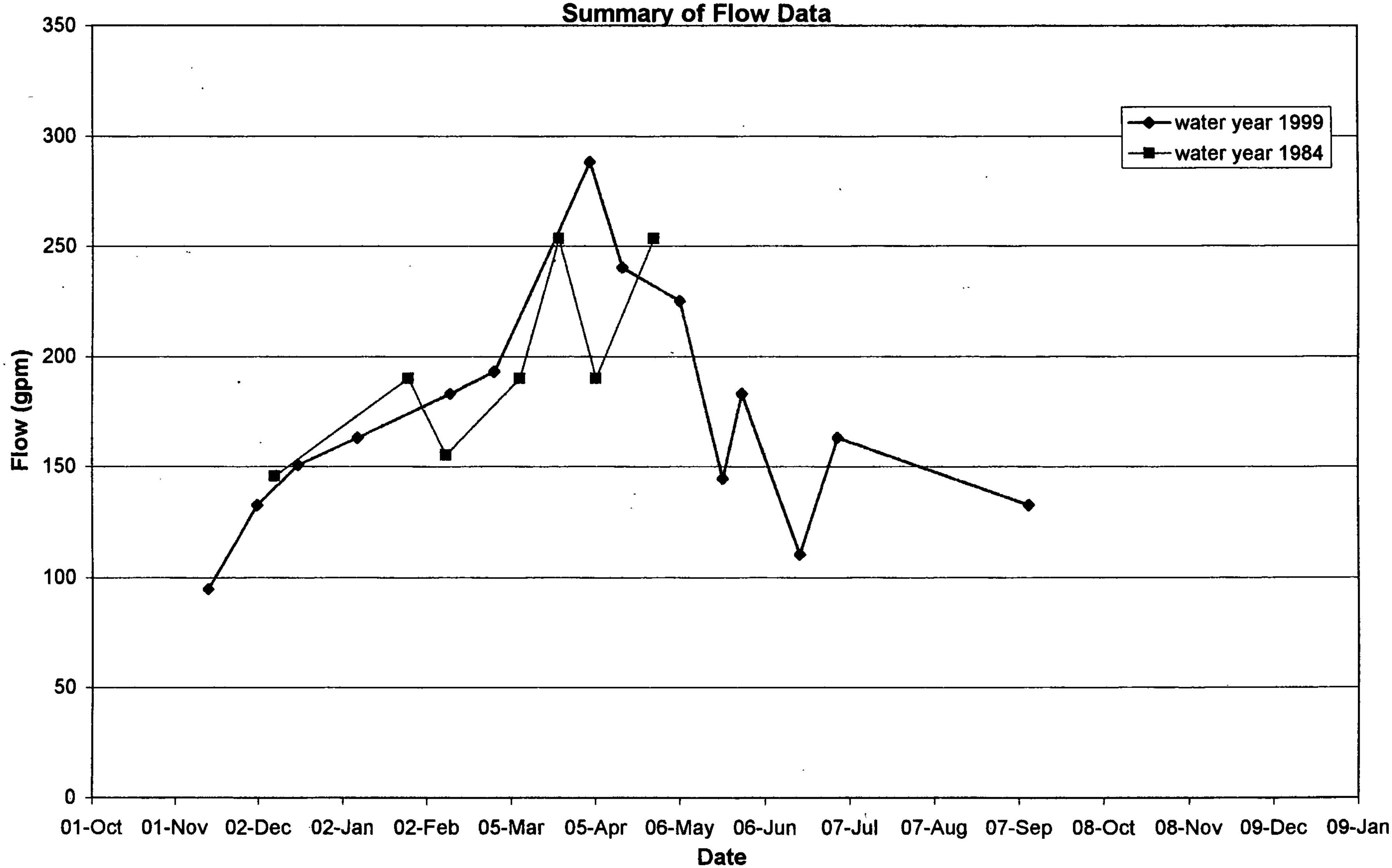

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Figure D-11
3HD
Summary of Zinc Loading Data

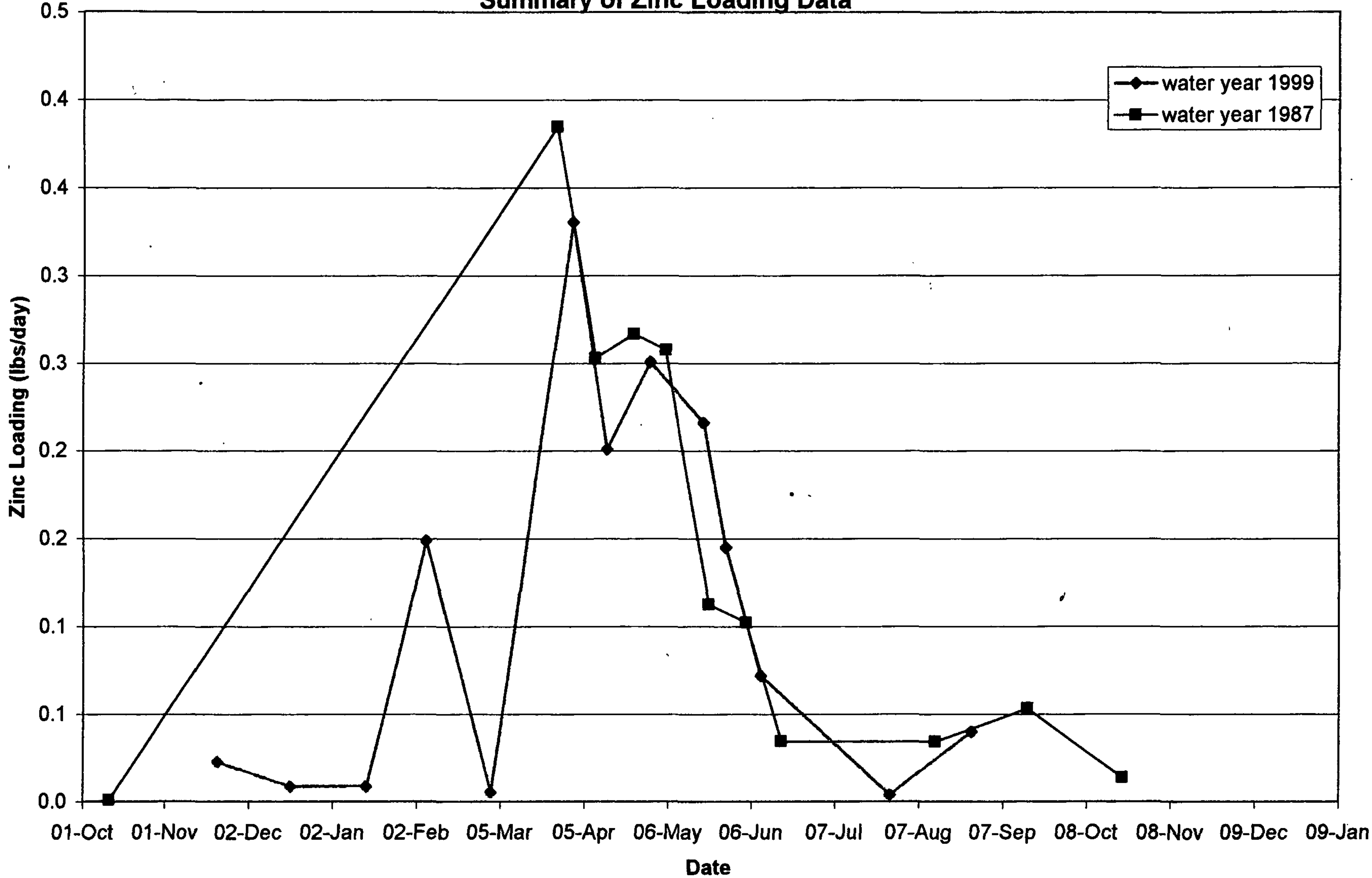

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Figure D-12
5WR
Summary of Zinc Loading Data

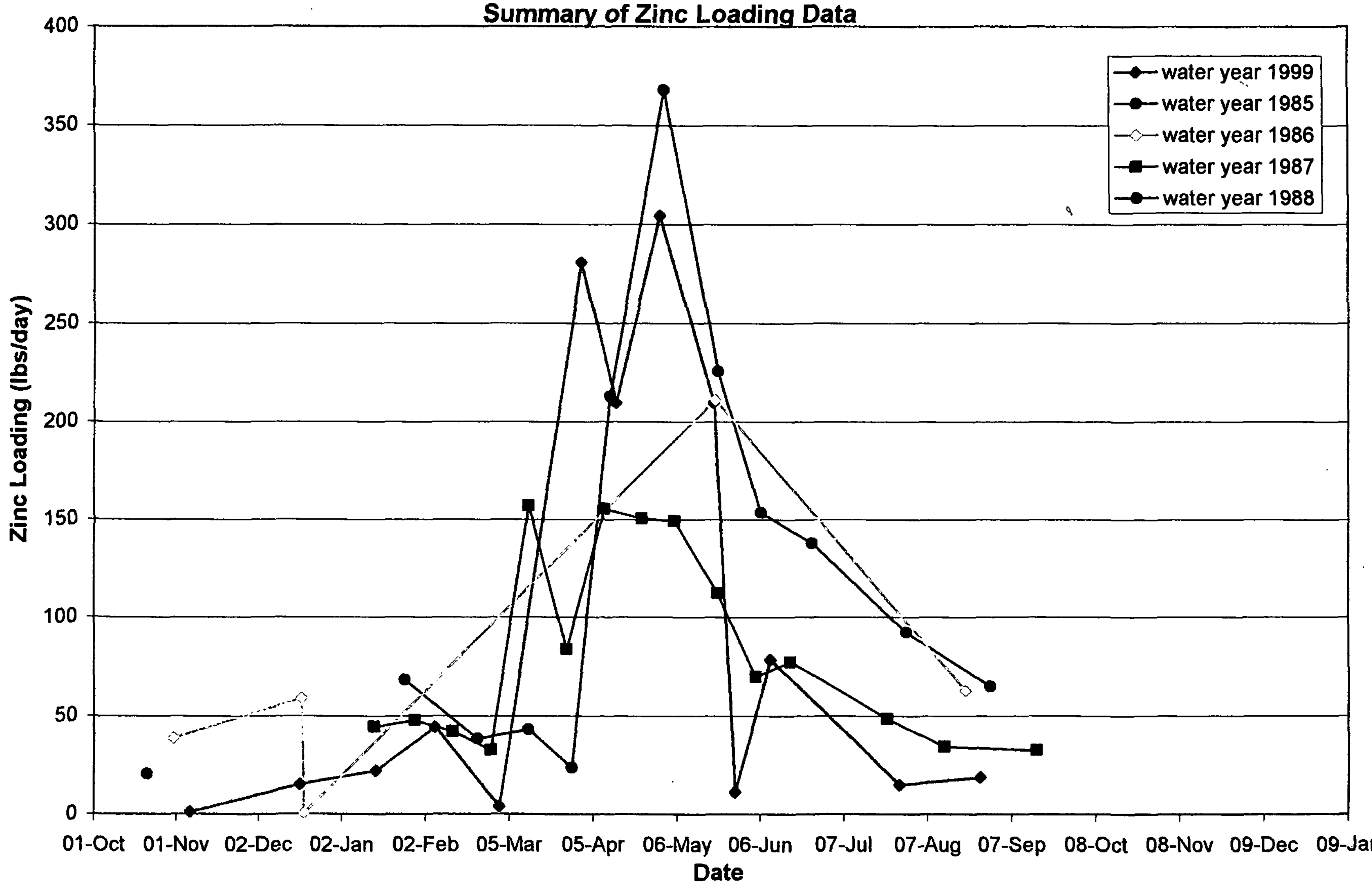

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Figure D-13
5BK
Summary of Zinc Loading Data

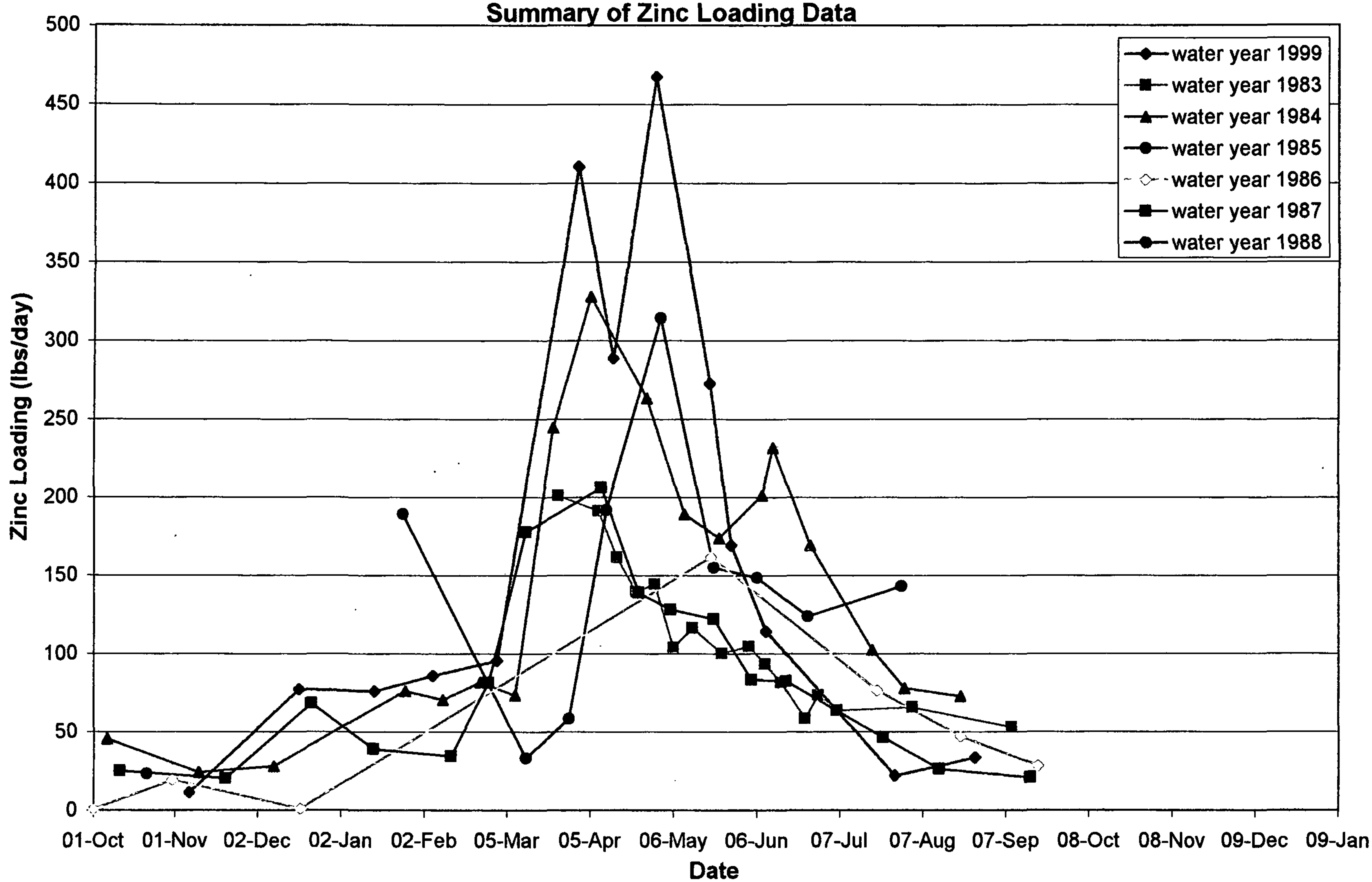

Figure D-14
5WM
Summary of Zinc Loading Data

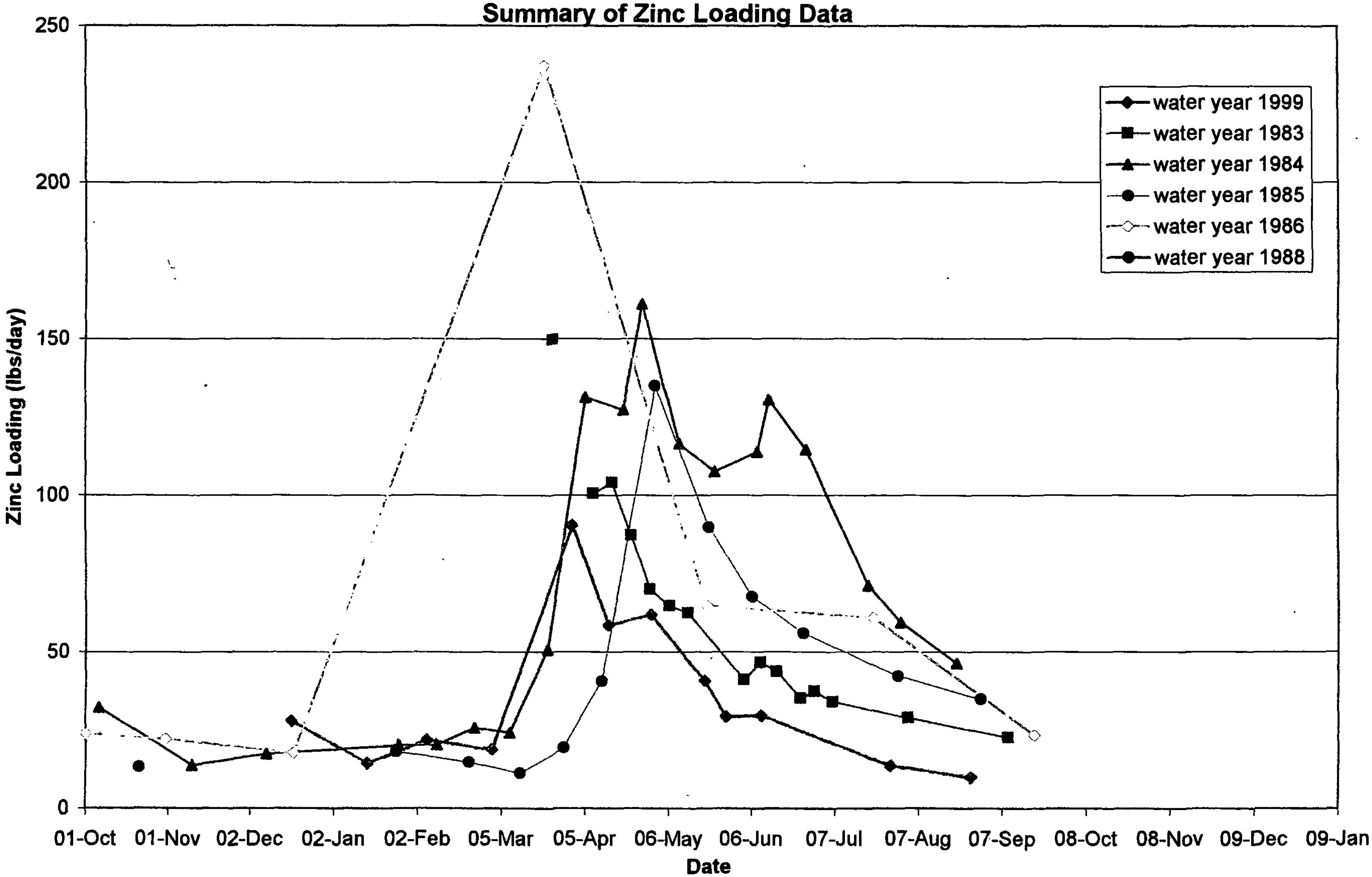

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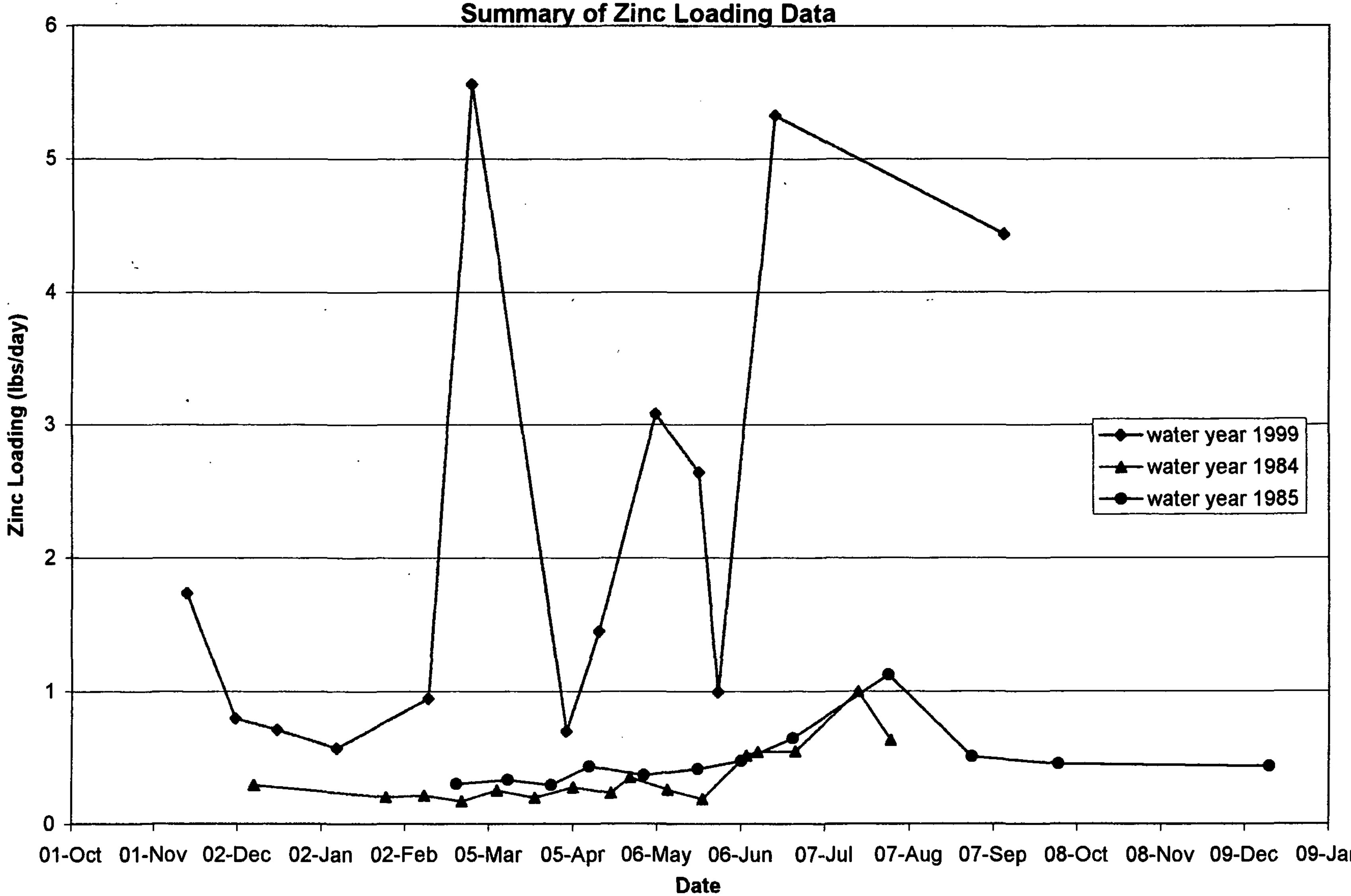
Figure D-15
9BO
Summary of Zinc Loading Data



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\1999 Final Summary\Flowinc Loading Summary- Past vs. Present.xls

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Figure D-16
9CR
Summary of Zinc Loading Data

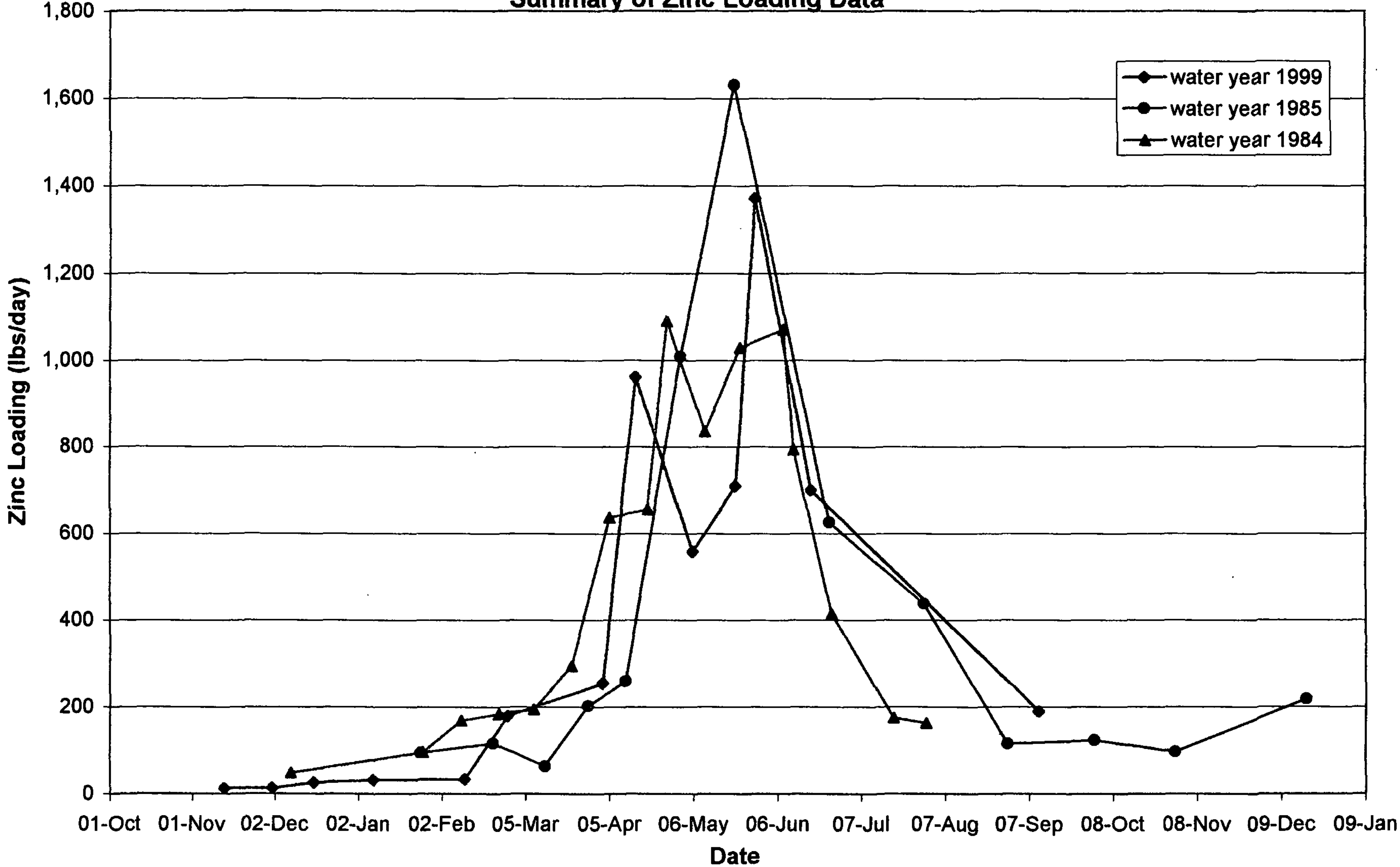

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Figure D-17
9SO
Summary of Zinc Loading Data

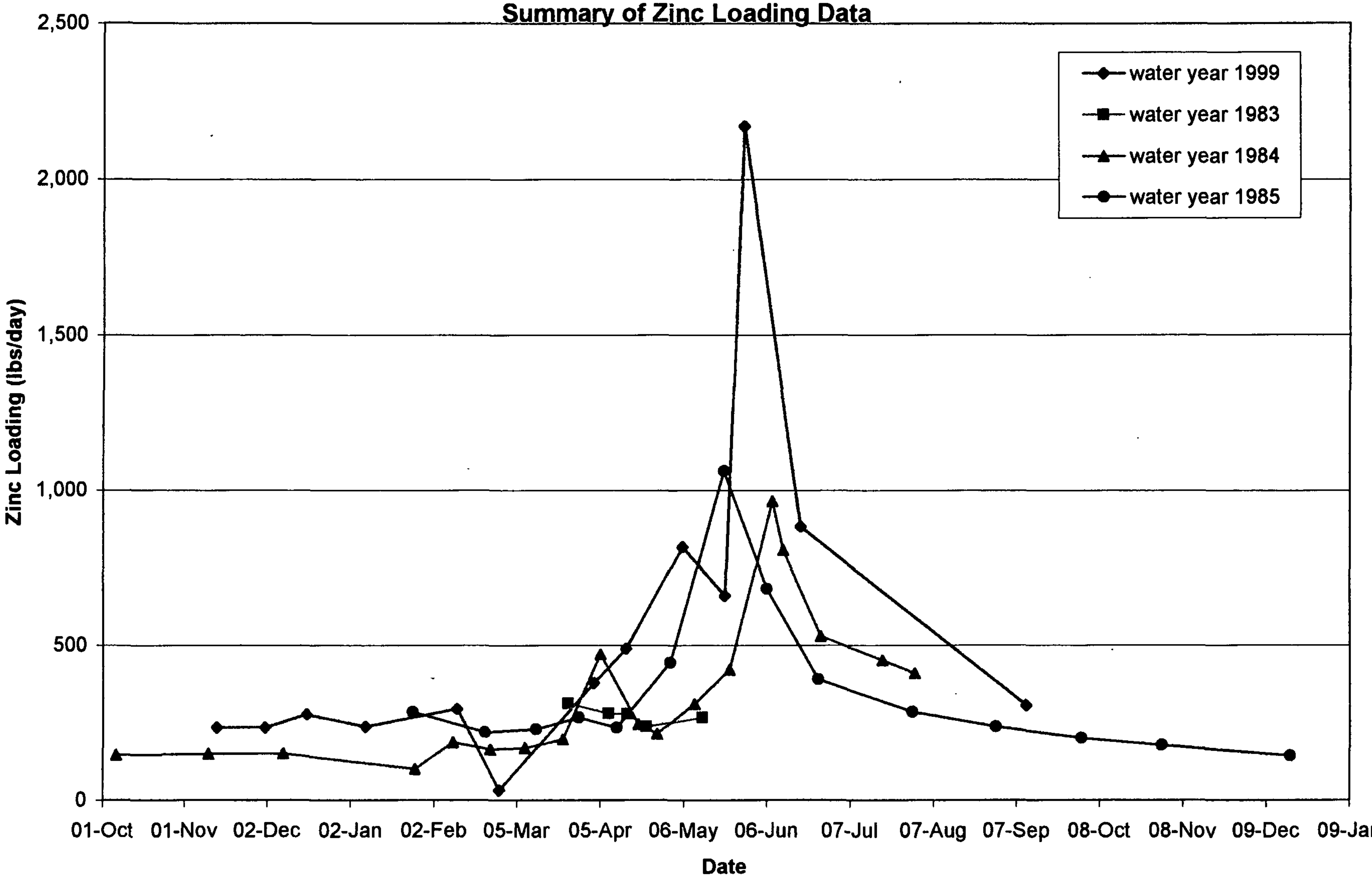


Figure D-18
9SX
Summary of Zinc Loading Data

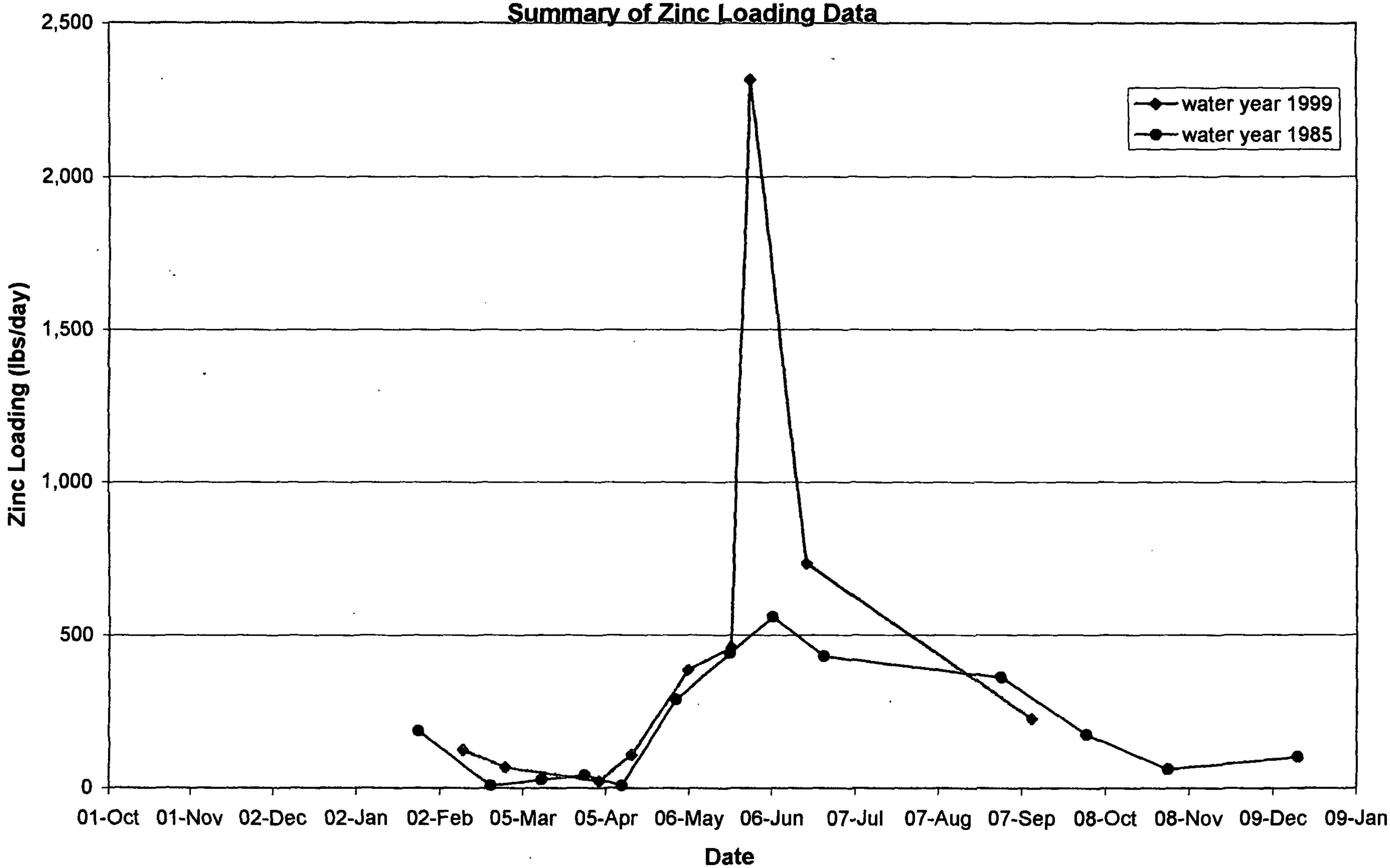
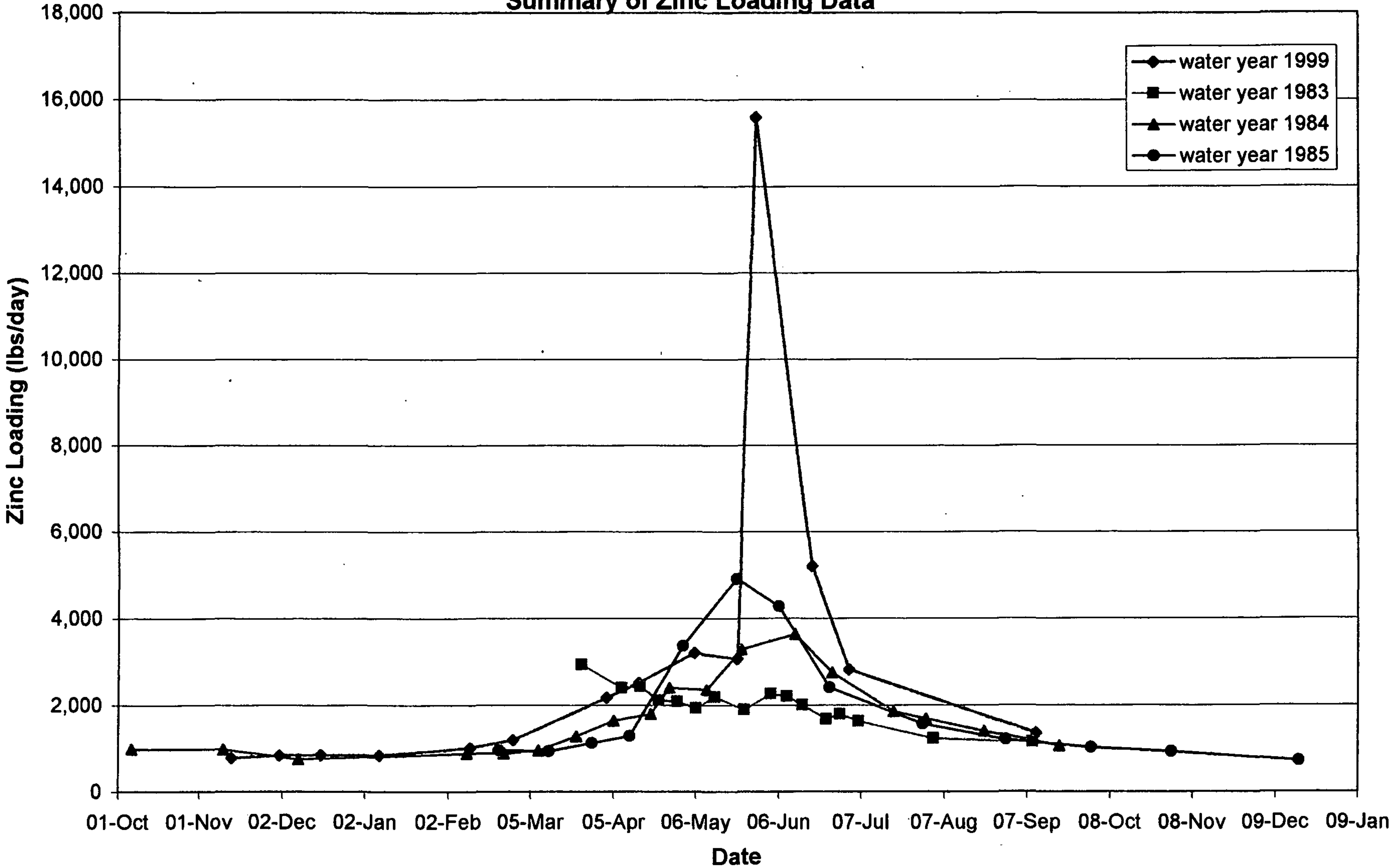


Figure D-19
9LA
Summary of Zinc Loading Data



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\1999 Final Summary\Flowinc Loading Summary- Past vs. Present.xls

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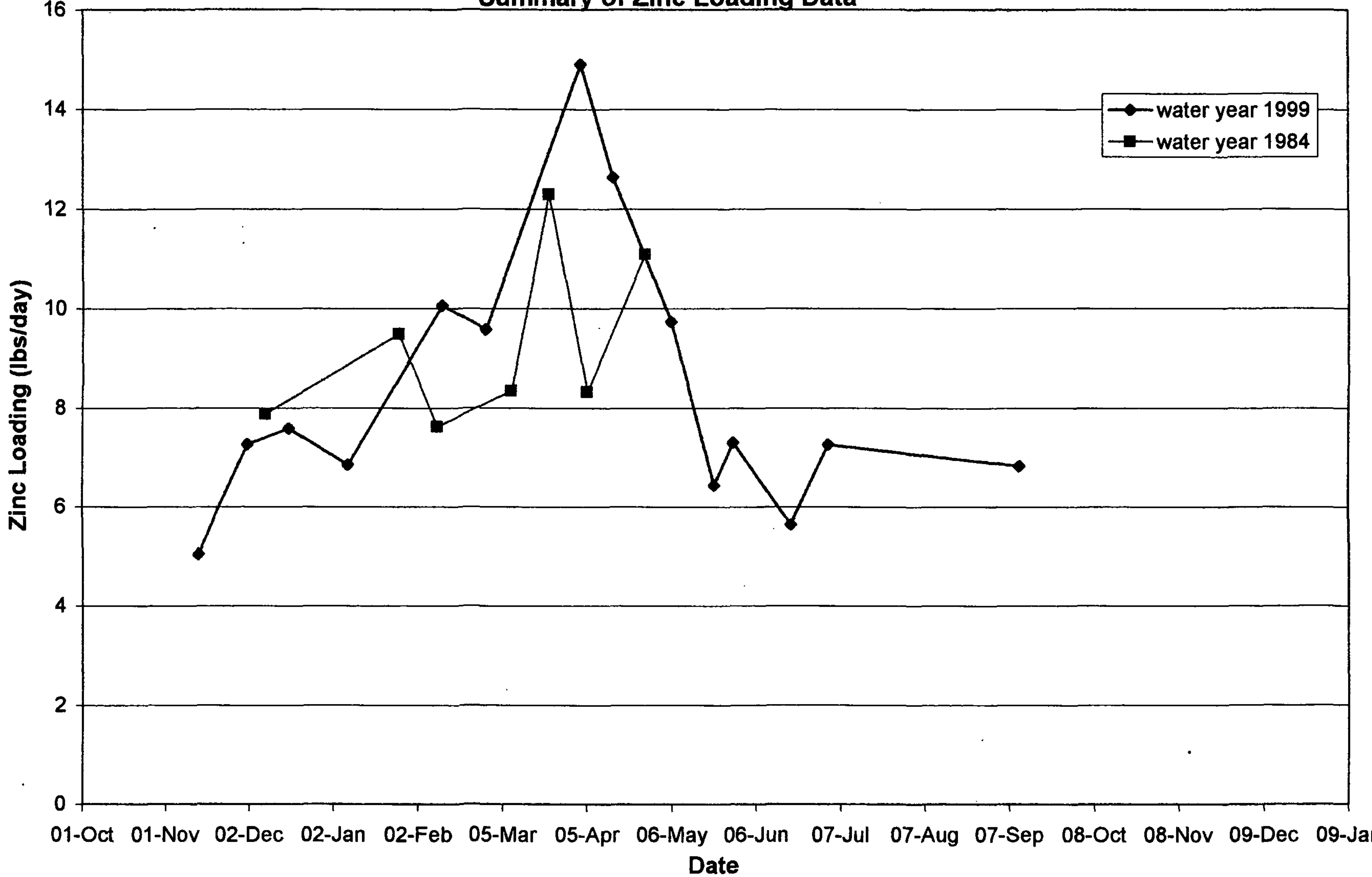
Figure D-20
9BS
Summary of Zinc Loading Data



upstream), which has since been designated Stanly Ore Chute #2. Considerable flow was also coming down a chute behind the muck dam (the dam is located immediately behind the flume) on the right side of the drift.

June 4 Recon

The second spring 1999 field recon occurred on June 4. Bill Hudson, Matt Germon, and Jim Stefanoff first went underground on 9 Level and made flow measurements and measured pH and conductivity at the monitoring stations. Bill noted that the Stanly Cross Cut flows were visually lower than on May 28. The flows were estimated via transit time through a known cross-sectional area to be about 375 gpm (this or the May 28 flow estimate may be in error). The flume was not used because it had been dislodged from its location, presumably by high flows.

After making the underground measurements they hiked up the West Fork and found that the flow had dropped down to an estimated 100 - 150 gpm directly upstream of the raise. The raise was not overflowing anymore and there was no standing water, but the bottom, which was about 4 feet lower than the previously observed high water mark, was muddy.

June 8 Recon

The third spring 1999 field recon occurred on June 8. Mary Kay Voytilla, Nick Zilka, Dale Ralston, Bill Hudson, John Riley, Matt Germon, Jay Dehner, and Jim Stefanoff hiked up to the Guy Cave vicinity. Matt and Bill separated from the group and hiked into the Phil Sheridan to measure flows at the back of the drift coming from the two raises and from the drill hole. The rest of the group hiked up to the Phil Sheridan raise. Flow from the West Fork into the raise had stopped and the raise had dried. The group hiked up about 200 feet to the end of the cat-track location which had been a possible diversion location identified last fall. There was no flow in the West Fork at this location, but water could be heard running upstream.

Mary Kay, Jay, and Jim hiked up the stream bed for a total of roughly 1000 feet up to the bottom of a talus slope which entered the stream channel from the west. The stream gained flow along the way, with the biggest gain appearing in the first 200 feet from the end of the cat track location. About 200 feet up there was a location where the channel narrowed, and a rock outcropping entered the channel from the east. This may be the Katherine Fault, but no clear determination could be made. No accurate estimate of the flow in the streambed could be made along this reach because it was difficult to quantify due to the alluvium.

Bill and Matt reported that about 5 gpm was coming down into the Phil Sheridan from both the east and west raises, and about 5 to 10 gpm from the open drill hole.

West Fork Milo Creek Spring 1999 Observations

TO: Mary Kay Voytilla/EPA

FROM: Jim Stefanoff/CH2M HILL

DATE: July 8, 1999

This memorandum describes observations of flow in the West Fork of Milo Creek made during three one-day reconnaissance visits during the spring of 1999. These occurred on May 26, June 4, and June 8.

May 26 Recon

The first recon occurred on May 26, 1999. Bill Hudson and Jim Stefanoff hiked up the West Fork drainage above the Guy Cave area and made the following observations:

- Flow in all the Milo Creek forks was up due to the spring thaw, and it appeared that runoff was near seasonal highs
- Water was flowing down the steep cat-track access road which is the approach to the West Fork. The water was flowing down the east side of the road and in the east ditch. The water seeped into the ground below the Phil Sheridan raise (the eastern raise constructed in the West Fork drainage, referred to as Raise #2 in the Joel Hunt Thesis) and it had all seeped in by the time it reached the point where the road curved east. However, water channels in the road lower than that location suggest that it had flowed further in the past.
- The raise to the Phil Sheridan was full of water and water was overflowing the raise through the talus at the east end of the downstream berm. Water was also flowing from springs at the base of the berm. These were the sources of the water flowing down the road.
- Jim Stefanoff estimated about 250 to 600 gpm was flowing into the raise.
- There was no water flowing into the western raise or sign of previous water flow (Raise #1 in the Joel Hunt Thesis).
- Bill and Jim hiked to the Phil Sheridan Portal and observed an estimated flow out the portal of about 50 to 100 gpm. This flow dropped over the hillside and seeped in, with no sign of it reemerging.

A 9-Level mine water monitoring event was conducted on May 28. It was found that an unusual amount of mine water was coming out of the Stanly Cross Cut. The capacity of the 9 Stanly Cross Cut flume was exceeded, and the flow was estimated to be about 300 gpm. This is over 75 times seasonal base flow. The strength of this flow was strong, with a conductivity of 5,200 and a pH of 0.99. The bulk of the flow being measured was coming down an ore chute located just behind the 9SO flume and on the left of the drift (looking

Appendix E

West Fork Milo Creek Spring 1999 Observations